THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

THE INSTITUTION OF

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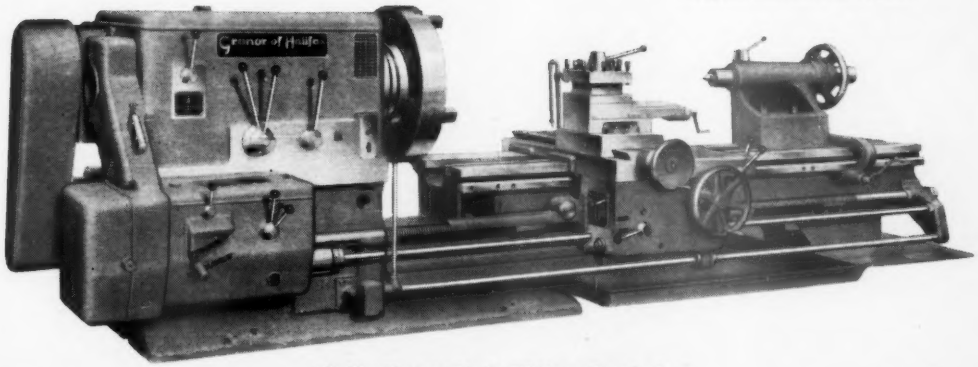

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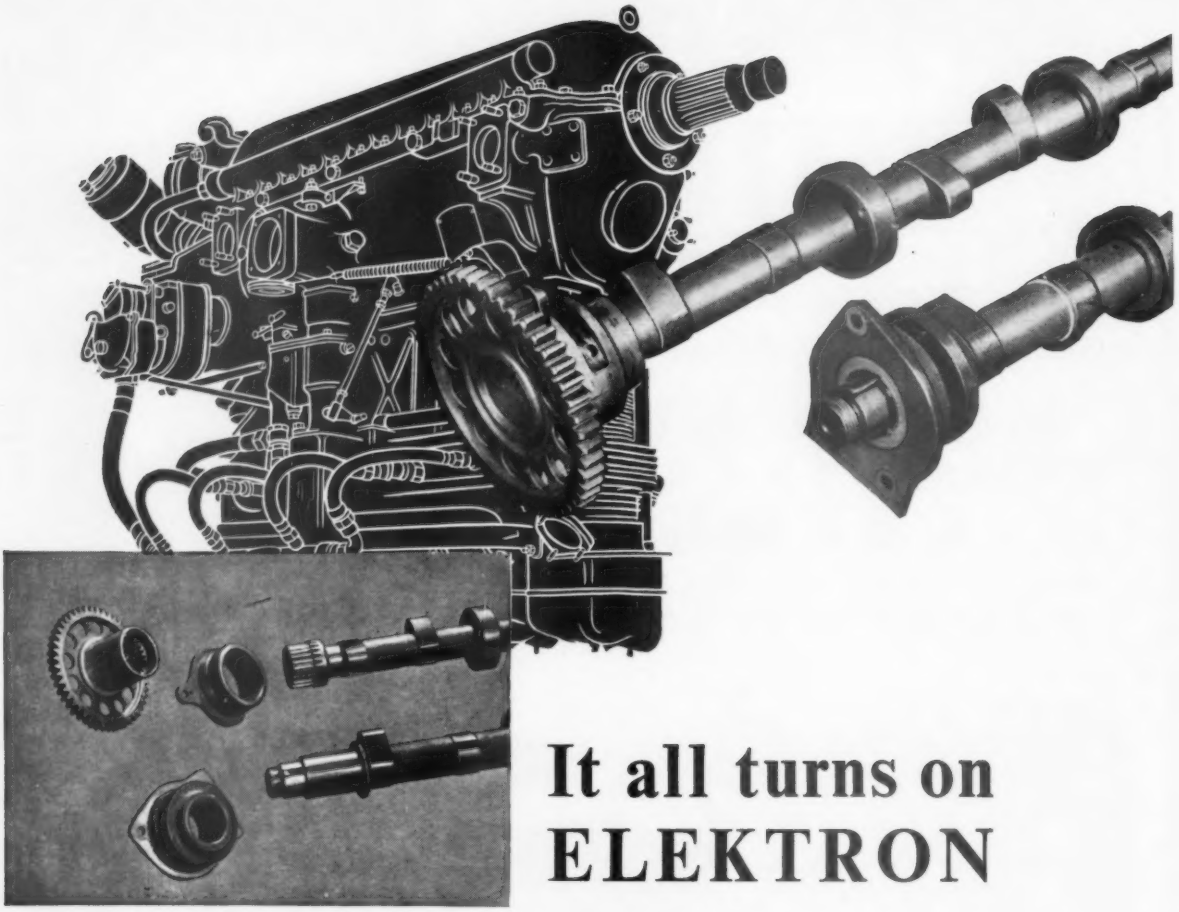

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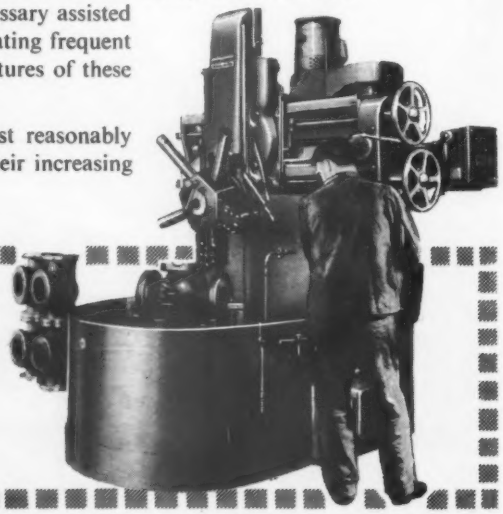

The illustration shows one of the battery of Webster and Bennett Boring Mills installed in the London Works of Dewrance & Co. Ltd., facing, turning, boring and screwing 5" valve bodies in a floor to floor time of 66 minutes.

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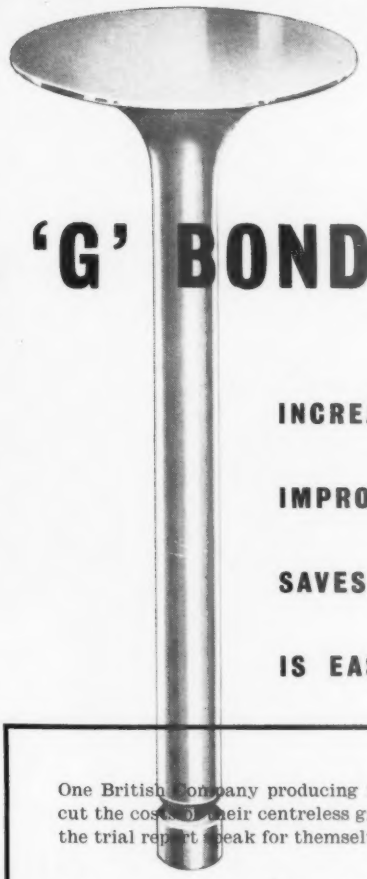

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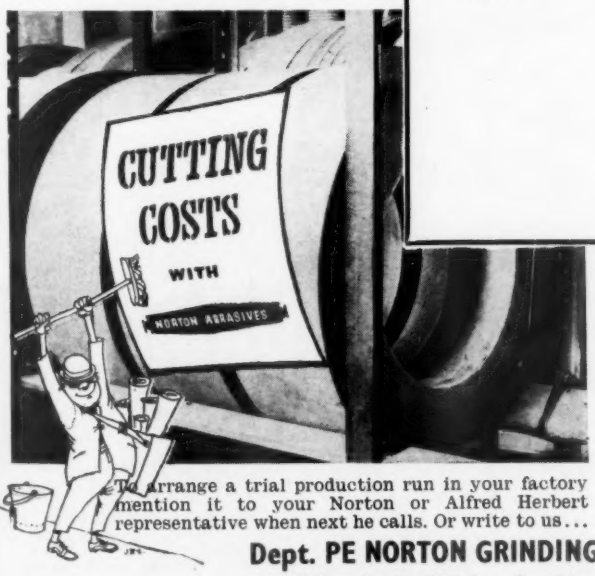

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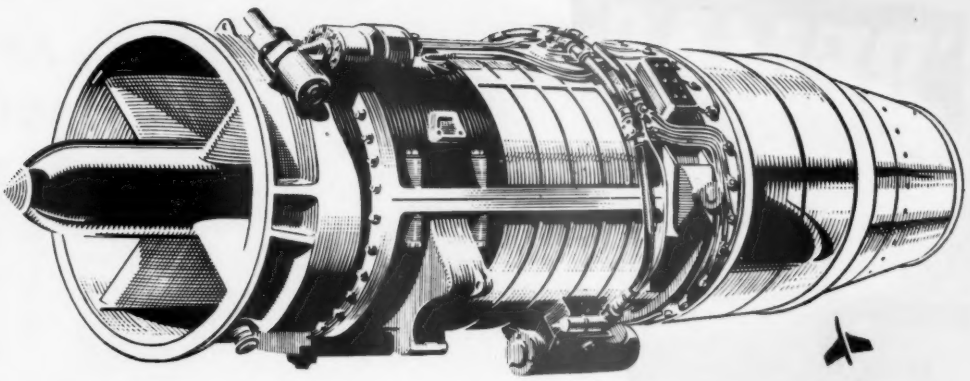

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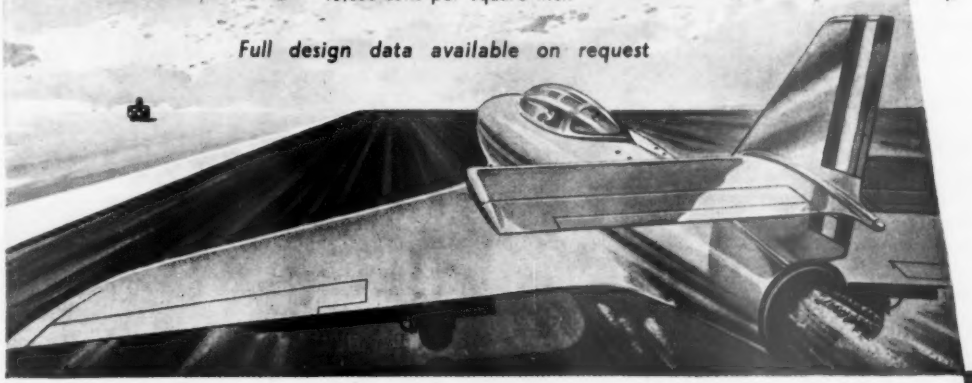

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Longitudinal Spindle traverse	50"
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Working area of Table	38" x 58"
Maximum distance spindle to base	47"
Maximum distance spindle to Table	31"
Down feed of spindle quill	13"
Vertical power adjustment of Table	17"
Spindle taper	No. 40
18 spindle speeds from	35 to 1800 r.p.m.
9 Boring feeds, from	.002 to .098"
Milling feeds, infinitely variable, from	0 to 9" per min.
Rapid traverse	150" per min.
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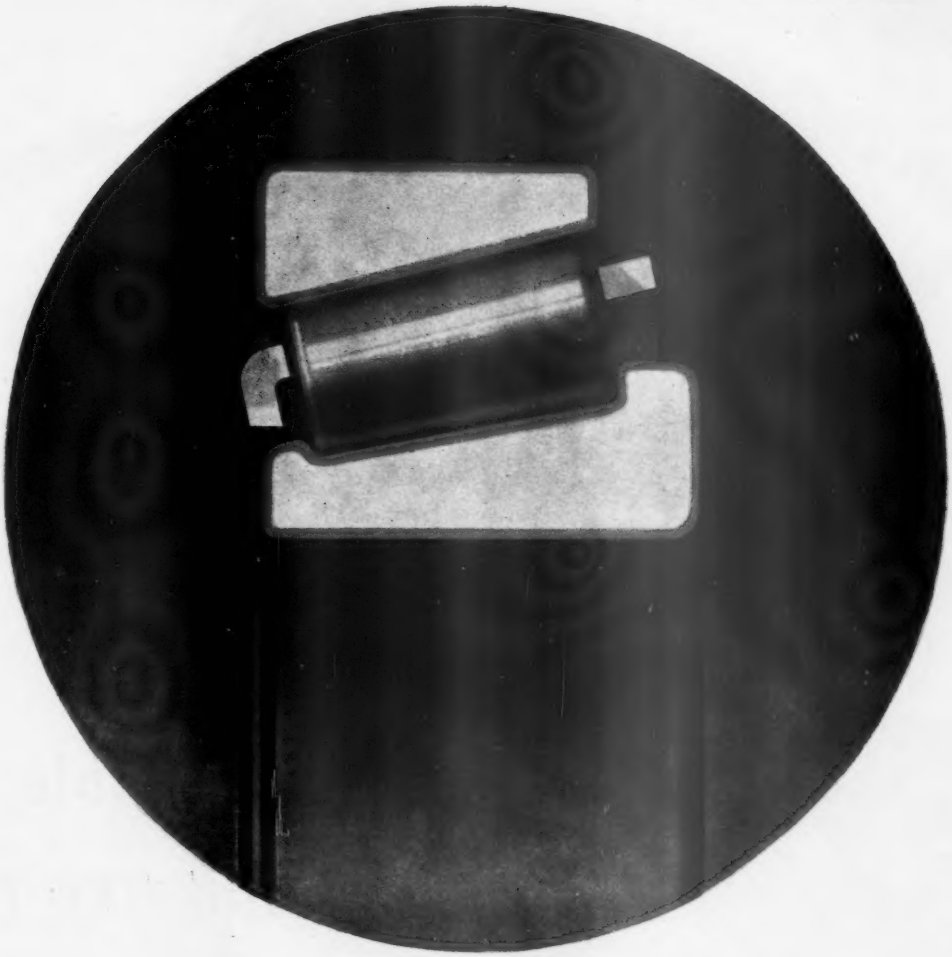

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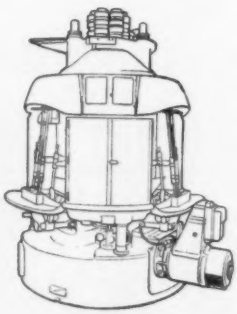
Upward drilling and tapping facilitates swarf clearance.
Arranged for chuck work.
Automatic chucking or hopper feed if required.
Capacities: Bar 1", 1⅝", 2⅜".
Chucking 4", 5½", 7½".



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SIP

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MP-3K

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Transverse travel of spindle saddle	14 in.—350 mm.
Distance from table top to spindle end max.	20½ in.—520 mm.
(retracted) min.	4¾ in.—120 mm.
8 spindle speeds	75—125—210—340—480—770—1250—2000 rpm.
GUARANTEED ACCURACY FOR ALL DISPLACEMENTS OF THE WORK-TABLE AND SPINDLE SADDLE	0.00015 in.—0.004 mm.

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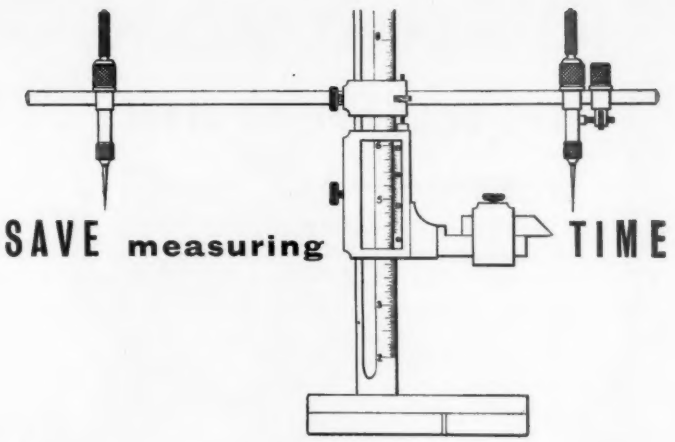
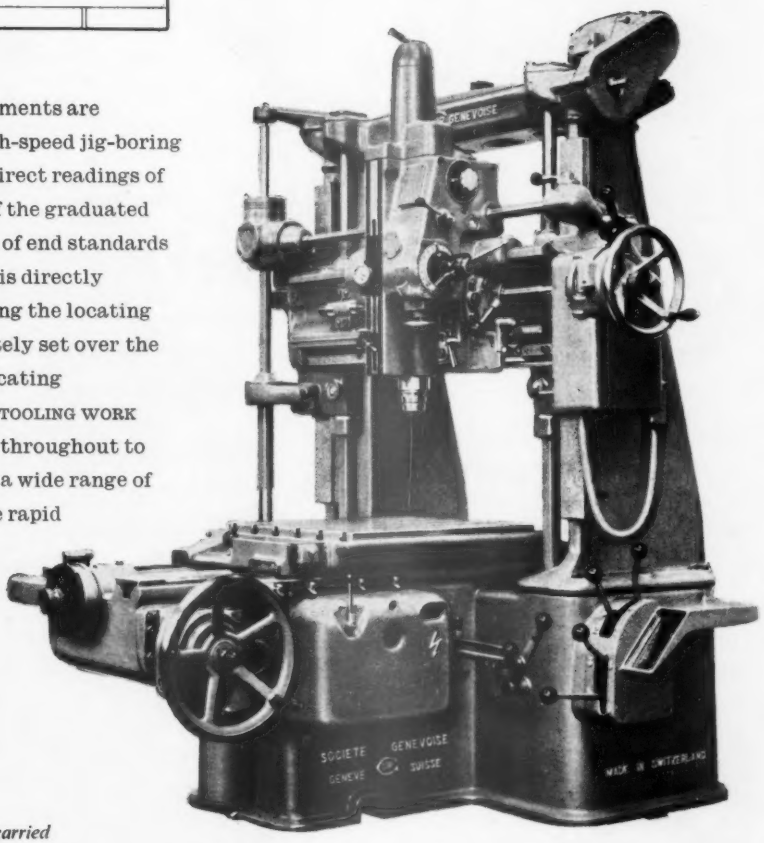


Even the most modern measuring instruments are unnecessary for machining with this high-speed jig-boring machine. Its micrometer heads permit direct readings of *0.00005 inch or 0.001 mm.* on the verniers of the graduated drums, and there is no need for selection of end standards or combining calipers and gauges. Work is directly mounted on the table and squared up using the locating indicator, the spindle then being accurately set over the origin of co-ordinates by means of the locating microscope. SAVING IN TIME AND COSTS FOR TOOLING WORK RANGE FROM 60 TO 80%. Substantially built throughout to withstand heavy duty, this machine has a wide range of speeds and automatic feeds which ensure rapid operation on various types of work.



MP-4G

The installation and service of this machine is carried out by the Area Engineers of Sogenique (Service) Ltd., under the GSIP guarantee.
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Longitudinal travel of table	24 in. — 600 mm.
Transverse travel of spindle saddle ..	20 in. — 500 mm.
Distance from table top to spindle end	max. 25 in. — 635 mm.
	min. 5 in. — 120 mm.
20 spindle speeds 50 — 60 — 70 — 85 — 110 — 130 — 150 — 185 — 230 — 280 — 350 — 425 — 480 — 600 — 750 — 920 — 1065 — 1300 — 1630 — 2000 rpm.	
GUARANTEED ACCURACY FOR ALL DISPLACEMENTS OF THE WORK-TABLE AND SPINDLE SADDLE	*0.0002 in. — 0.005 mm.*

GSIP

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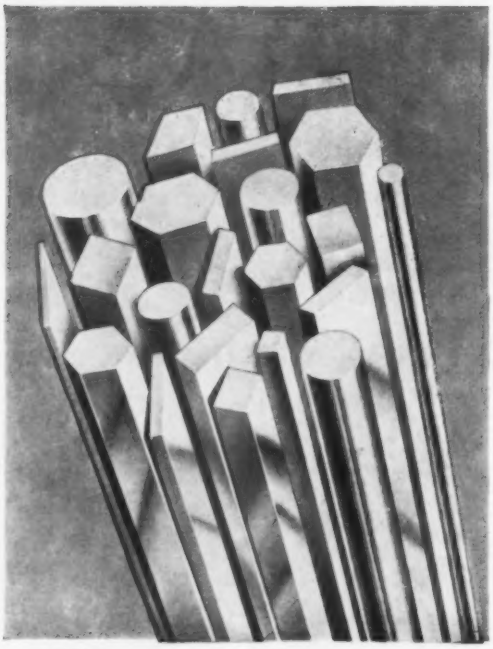

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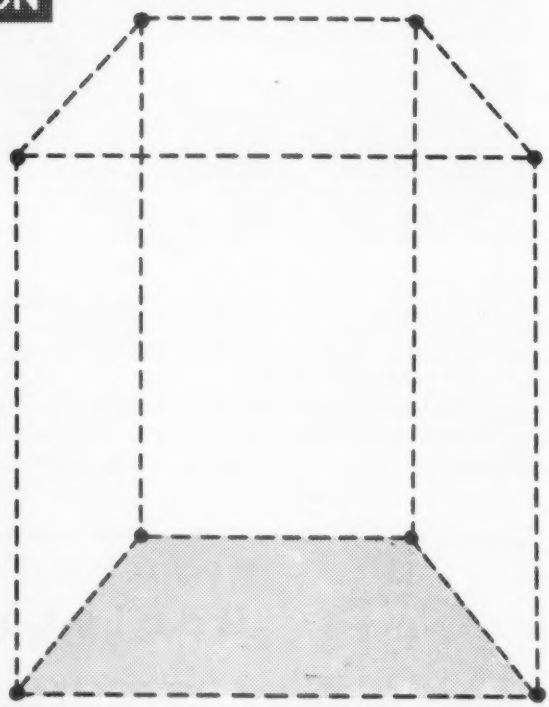

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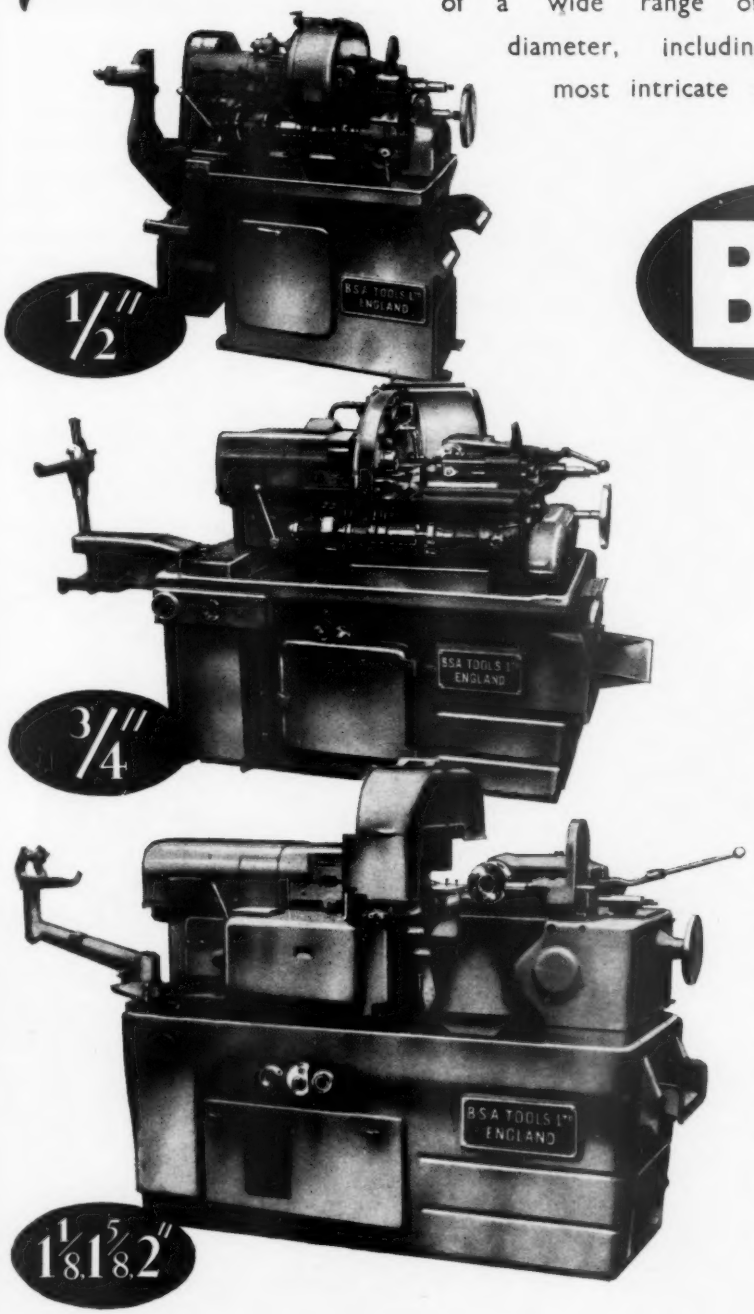

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FOR ACCURACY AND FINISH

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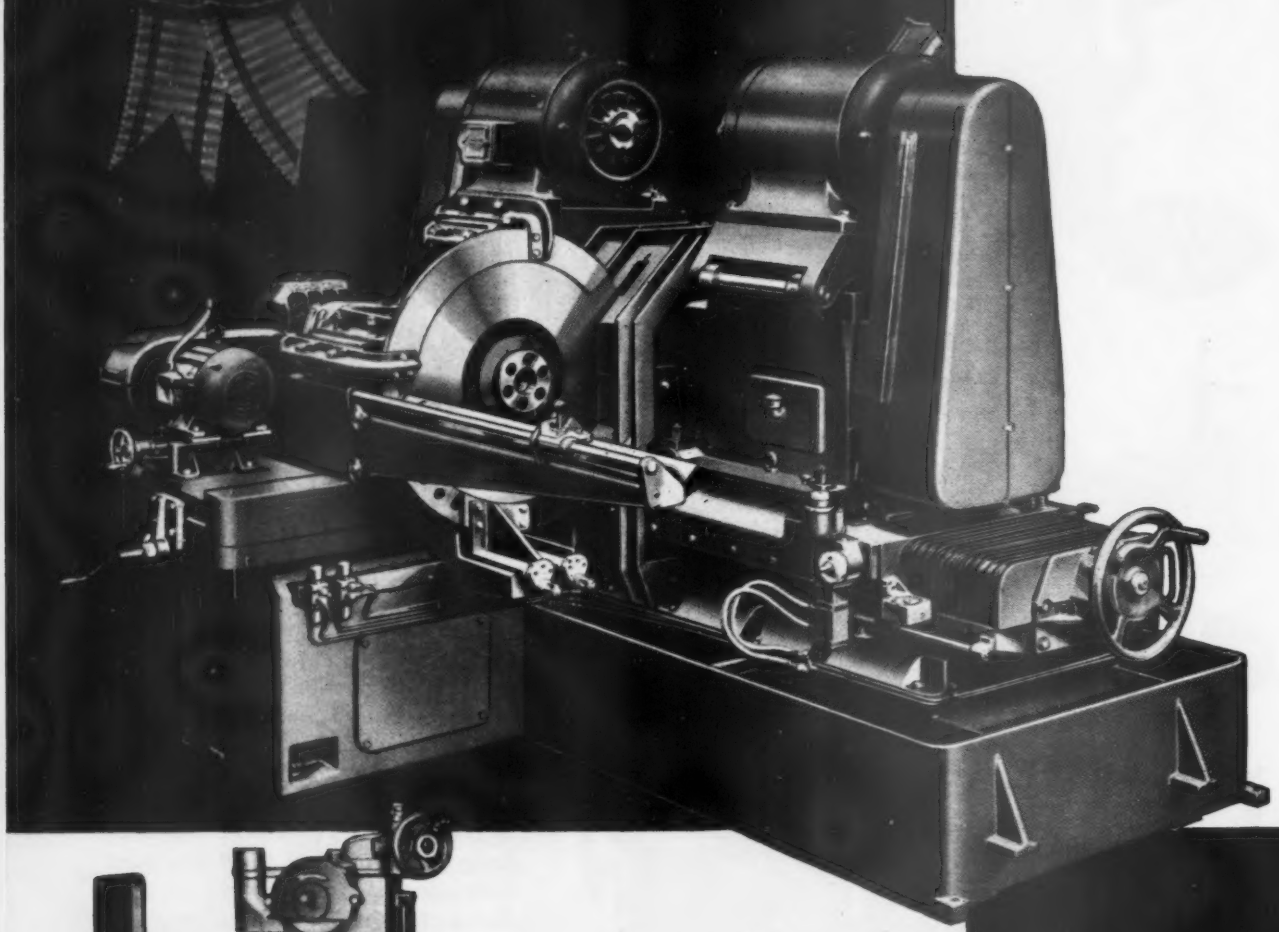

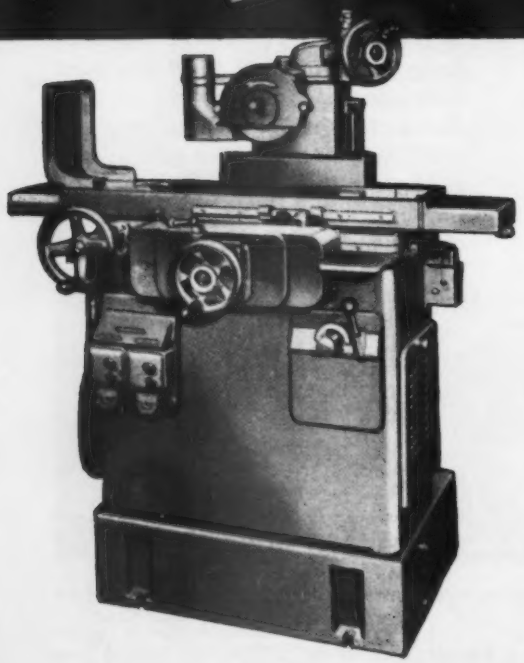

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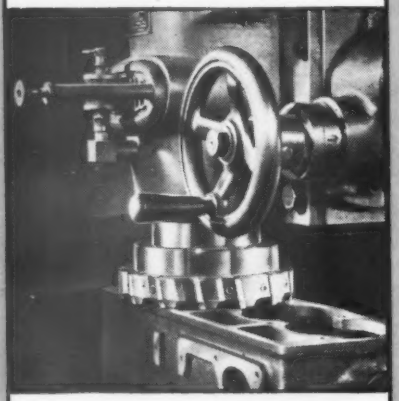

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The Institution of Production Engineers Journal
VOL. 35. NO. 3. MARCH, 1956

1956 Conference on "Problems of Aircraft Production"

University of Southampton, 6th/7th January, 1956

THE Chairman, Mr. F. T. West, M.B.E. (*Chairman of the Southern Section*) on behalf of the Institution and in particular of the Southern Section, welcomed all those attending the Conference. At previous Conferences, he said, a Minister of the Crown had been present, and, he humorously suggested, that had Sir Anthony Eden approached Mr. Woodford, the Secretary of the Institution, before making the recent Cabinet changes, there might have been a Minister present that day! The fact that there was not, however, need cause no disappointment, because there was a very fine list of speakers at the Conference, and at the Luncheon they were honoured by the presence of Alderman Hammond, the Deputy Mayor of Southampton, and Mr. D. G. James, the Vice-Chancellor of the University.

Those present who lived and worked in the neighbourhood knew that Alderman Hammond was a very busy man, and it was difficult to imagine what Southampton would do without him. Without the co-operation of the Vice-Chancellor the Conference could not be held, and the Institution wished warmly to thank him and all those who were responsible at the University, for the excellence of the arrangements which they had made.

The Conference was honoured by the presence of some fifty distinguished visitors, to all of whom the Chairman offered a cordial welcome. It was impossible to mention them individually, but he would like to take the opportunity, on behalf of the Institution, of thanking Mr. F. L. Freeman, the Chief Education Officer of Southampton, for the work which he and his Education Committee were doing for the training of production engineers. "I believe," the Chairman remarked, "that the production engineering department at the Southampton Technical College is reasonably well staffed and well governed, and very well equipped."

If those attending the Conference missed some old friends that they had expected to meet there, the explanation was not loss of interest on the part of those who were absent but that more applications to attend the Conference had been received than could be accepted.

Alderman R. R. H. Hammond conveyed the apologies of the Mayor for her inability to be present and offered the Conference a very warm welcome to Southampton. It was an honour to Southampton, he said, to be selected as the venue for such a very important Conference on such a very important subject, a subject which assumed even greater importance today in view of the unpalatable news that two large European air lines had decided to place their orders for new aircraft with American firms. He was confident that the great British aircraft industry would do all in its power to see that before many months had passed Britain was once again producing air liners which would be world renowned for safety and speed.

Speaking as a 'man in the street', it seemed to him that if this country were to maintain its position as one of the leading nations of the world it must keep in the front rank in the production of aircraft, rockets and even space-travel ships. They might not live to see space travel, but he was confident that within the next decade

it would become possible to travel right round the world in 24 hours, journeys would be made in outer space, business executives would travel in a form of helicopter, and it would be possible for a man to take his family in his own air transport for a week-end by the Mediterranean, or even in Florida.

He had not much association with aircraft production, but he had travelled by air and realised the paramount importance of air transport. Much of the prosperity of the town — he hoped that before long it would be possible to say the city — of Southampton was due to the aircraft industry of the area, and it was the desire of the Southampton Corporation to do all in their power to ensure that every facility which that industry desired was made available.

The local authority were conscious of their responsibilities to industry and realised that the continuing prosperity of their town depended on the attraction of further industries. A considerable area had been scheduled for this purpose. They were fortunate in having a young and virile University and a Technical College of great and growing importance, due to the energy of Mr. West and his staff. They were confident that Southampton could provide all the technical staff required for any new industries which came to the town.

He wished the Conference every success and hoped that its deliberations would be of benefit to the aircraft industry and to the country as a whole.

Mr. D. G. James (*Vice-Chancellor of the University*) said that it was a very great pleasure to the University to be chosen as the meeting-place of the Conference. There must increasingly in the future be greater communication between the world of production engineering and the world of the universities. Inevitably, as the years went by, more and more of the ablest young men in the country would go to the sixth forms of their schools and then to a university for their training, and the implications of this for production engineering would have to be considered. A growing number of university graduates would go to swell the ranks of production engineers.

Many years ago there had been an elderly professor at one of the older universities who was proud of his prowess as a cyclist and liked to go for runs in the country with his young undergraduate friends. On one occasion he put on a burst of speed and left them far behind. When they caught up with him they found that he had had a puncture and was busy pumping air into the sound tyre. One of the boldest undergraduates remarked: "Perhaps we ought to explain certain features of this situation to you. When you have a puncture it is necessary to pump air into the punctured tyre, not the other one." The professor replied: "Thank you for being so helpful, but do not the two tyres communicate?"

Mr. James remarked that he had often thought that the professor of the story could not have been an arts man, because professors of arts were quick to see the relationship between things; he must have been a professor of science, or possibly of engineering. The moral of the story was that there must be increasing communication between the worlds of production engineering and of the universities, because the universities must do more and more to help to fill the ranks of production engineers and thereby help to diminish the great gap which still existed between the production of the prototype and quantity production.

"The continued existence of this gap," Mr. James said in conclusion, "calls for consideration of what the universities can fairly be expected to do in order to ensure that this gap between design, development and production may be reduced. What the universities can do I do not know, and whether you know I do not know either, but if you do know I hope that you will tell us."

The University would be delighted to continue to put at the disposal of the Conference the facilities which they possessed, and hoped in the future to have still further facilities to make available.

CONFERENCE PROGRAMME

Theme : " SPEEDING AIRCRAFT PRODUCTION "

(This Journal contains a report of **Sessions I** and **II.**
Sessions III and **IV** will appear in the April issue.)

SESSION I

Chairman : Sir Walter Puckey, M.I.Prod.E., F.I.I.A.

The Lord Sempill Paper

" BRITAIN'S AIRCRAFT NEEDS " by Sir Roy Fedden, M.B.E., D.Sc., Hon. F.R.Ae.S., M.I.Mech.E., F.R.S.A., Hon.F.I.A.S., Hon.F.S.A.W.E.

SESSION II

Chairman : E. F. Gilberthorpe, A.M.I.Mech.E., M.I.Prod.E., A.M.I.I.A.

" TIME CAN BE SAVED — IN THE AIRCRAFT INDUSTRY " by H. G. Gregory, M.I.Prod.E. and A. Vines, A.F.R.Ae.S., A.M.I.Prod.E.

SESSION III

Chairman : H. W. Denny, M.I.Prod.E.

" CONTROL OF PRODUCTION PROCESSES " by I. R. Smith.

SESSION IV

Chairman : S. P. Woodley, M.B.E.

" MACHINING RESEARCH AND ITS IMPACT ON SPEEDING PRODUCTION " by D. A. Oliver, C.B.E., M.Sc.(Eng.), F.I.M. ; T. S. Lister, B.Sc., A.I.M. ; D. Fitzgeorge, Ph.D., A.M.I.Mech.E. ; and M. D. Kinman. (*This Paper was sponsored by the Machine Tool Trades Association.*)

SUMMING UP

by the Right Hon. Lord Sempill, A.F.C., Hon.M.I.Prod.E.

SESSION I

(THE LORD SEMPILL PAPER)

BRITAIN'S AIRCRAFT NEEDS

by SIR ROY FEDDEN, M.B.E., D.Sc., Hon.F.R.Ae.S., M.I.Mech.E.,

F.R.S.A., Hon.F.I.A.S., Hon.F.S.A.W.E.

Sir Roy Fedden

Sir Roy Fedden is one of those great pioneers of the aircraft industry whose name has been closely linked with aircraft for nearly half a century. Educated at Clifton College and Merchant Venturer's College, Bristol, he served a five-year apprenticeship in the motor industry.

In 1908 he joined Straker Squire Limited of Bristol, designers and manufacturers of a variety of different types of motor vehicles. He joined the firm as a draughtsman and eventually through various promotions became Technical Director.

In 1914 Sir Roy Fedden was commissioned in the Royal Navy Volunteer Reserve but he was returned to civilian engineering duties and from 1915-1919 he was again at the Straker Squire Works manufacturing complete Rolls-Royce and Renault aero engines. He was responsible for the production of 2,500 aero engines for the First World War, for which he was awarded the M.B.E. He won an Admiralty competition for air-cooled radial design in 1917.

In 1920 he joined the Bristol Aeroplane Company and founded the Engine Department. He was appointed Chief Engineer and until 1942 was responsible for the design and development of all Bristol aero engines.

In 1942 he was appointed Special Technical Adviser to the late Sir Stafford Cripps, who was then Minister of Aircraft Production, and for the two years immediately after the War Sir Roy was engaged in gas turbine research work for the Ministry of Supply. In 1952 and 1953 he was Aircraft Technical Adviser to N.A.T.O. Since 1946 he has been a member of the Board of Governors of the College of Aeronautics, Cranfield, and since 1948 he has been Chairman of the Advisory Committee on Aeronautics of the City and Guilds of London Institute.

He has won numerous awards throughout his very active life, including the Guggenheim Gold Medal and the Lilienthal Ring, and has been honoured by many countries. He was created a Knight in 1942.

FOREWORD

I feel most honoured to have been asked to give the first address for the Lord Sempill Paper at this Fourth Annual Aircraft Conference of the Institution of Production Engineers.

I have had the privilege of knowing William Sempill for just on 40 years, since the days of the First World War. Having served an apprenticeship with Rolls-Royce, he joined the Royal Flying Corps in 1914, transferred to the Royal Naval Air Service in 1916, and ended up as a full Colonel in the Royal Air Force in 1918.

In the summer of 1918 he went to America with Sir Sefton Brancker on a Technical Advisory Mission In 1921 he led a mission to Japan to advise on organisation, equipment and training of a naval air service. He gave similar counsel to Greece, Chile, Brazil, The Argentine, Sweden and Norway. In the early '20s, wherever there was a worthwhile aeronautical committee it was certain to find the name of the Master of Sempill among its members. I have never known anyone who has told so many countries what is the best thing for them in aviation, including buying British aircraft and engines.

In the late '20s he did an immense amount for British gliding, and in 1938 became President of the British Gliding Association. Every year from 1924 to 1930 he competed in the King's Cup Race and flew his own light aeroplane all over Europe and beyond to the Antipodes, in order to popularise private flying, develop air routes, and stimulate British commerce.

As a member of Council of the Royal Aeronautical Society, he was energetic and forceful in the early years after the War, and was President from 1927 to 1930. He played a great part in publicising the Society, encouraging the formation of branches and drawing attention to the technical importance of the Society. He was responsible for the Society staging its remarkable exhibit at the 1929 Olympia Aero Show.

With his lectures, speeches, and practical flying demonstrations in between the Wars he did as much as any one individual could to rouse people to the importance of the air to the future of this country.

In the House of Lords, as elsewhere, he continually expressed a sound and independent point of view on air matters which was not always acceptable, however, to the powers-that-be.

Of recent years he has devoted the greater part of his attention to maintaining a live and progressive interest in the production side of engineering, serving for many years on the Council of the Institution of Production Engineers, of which he is a Past President, and playing an important part in debates of the Upper House on all matters relating to aircraft production.

Finally, out of all his many interests, I would mention one of the most important in " human production and efficiency ". Lord Sempill is a first-class cook, and if he had not followed aircraft engineering he might easily have become the " Philip Harben of the Air " ; for to taste one of his orange soufflés is something to remember.

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1. I CONSIDER it a great privilege to deliver this address to such a distinguished audience. I must let you into a secret. The title was selected for me by Lord Sempill and the Secretary of the Institution. For better or worse, lulled by the security of the soothing atmosphere of the Athenaeum, and fortified by its immaculate buttered scones and tea, I fell for these gentlemen's persuasions and undertook this tough assignment which, believe me, is no sinecure. " Rushing in where angels fear to tread ", I have fairly and squarely entered the arena of aircraft production controversy, and, although I am still doubtful if I should have accepted the invitation, I hope I shall weather the storm. In endeavouring to make some contribution to this occasion I am in good company, for in 1954 our Chairman today so ably lectured on " Where Goes the Aircraft Industry ? ", and in summing up the Third Aircraft Production Conference of the Institution a year ago, Mr. Petter, with a realistic and practical slant, put forward his plea for " Where do we go from here ? " : the first lecturer saying the biggest problem of the aircraft industry was to get production rolling, while the other advanced the theory that it was to provide conditions in which design and development could prosper. In spite of the sound advice from both these experienced specialists, the patient is still far from well. I wonder if a little shock treatment might help ?

2. During this Conference we shall hear views on specific aircraft production problems. In this broader introductory survey, an attempt will be made to take stock of the position since the War, how we have fared to date, and how we might plan for the future.

3. The first question I suggest we might therefore consider, is :-

" What are the nation's needs in aircraft ? "

I presume we should all fully agree that they are primarily to have an adequate Air Force to defend ourselves against an aggressor, and then in the very pressing and ever-increasing air transport field to have a sufficient range of competitive types to meet our

own needs, as well as to reap a reasonable share of the valuable world market for the next 10 years ahead, so as to occupy the hard core of our now important aircraft industry, which employs about 250,000 people.

4. There can, I venture to say, be no doubt at all of the vital need for these requirements. In spite of all the "soothing syrup" of the Summit talks way back in the summer, followed by the Geneva fiasco, let there be no doubt whatsoever that there has been no change in the Kremlin's tactics or ultimate aims. Recent articles in the Press have, I hope, at last brought home the true facts to the man-in-the-street.

4.1 "The Times" reported fully on a N.A.T.O. conference held on October 10th last, at which General Sir John Whiteley, Chairman of the Permanent Chiefs of Staff, said that Russia retains the same number of active divisions, but they are greatly improved in quality and equipment, and the same remarks apply to her Air Force. The Soviet Bloc, therefore, retains the initiative, and, in Sir John's view, the threat is now greater than ever. At the same conference Admiral Wright, U.S.N., Commander-in-Chief Atlantic, stated that the Russians possess the largest submarine fleet the world has ever known, exceeding that of all other nations put together.

4.2 During 1955, the Press has been full of statements and reported speeches, relating to the expansion and competition on main line world air transport. The stakes are indeed high, and are stated to be of the order of 2,500 - 3,000 aircraft, costing the colossal figure of £2¼ billion sterling, spread over the next 10 years. These figures take no account of the smaller feeder and personal types of aeroplane. These requirements bring home how important it is for our civil air liners to be of such calibre as to attract a fair share of this important world export market.

5. The next question before us is: "Has the nation sufficient aircraft of the right type to meet these widely differing needs?" The answer is definitely "No". On the defence side, sufficient money and effort have been expended, and time elapsed, for us to have had by now 2,000 modern swept-wing fighters and 500 strategic bombers: but actually, we must have in service I imagine under 600 of these fighters and less than 50 "V" bombers. Sober fact though it is, America cannot, therefore, look to us for the next few years to make a serious contribution in the air in the event of an emergency. In fact, our position in this respect today is relatively not very far removed from that of Poland at the beginning of the last War.

As regards civil aviation, we have achieved outstanding success in one new world market. The next 12 months is a tremendous testing time for certain other new types which are just coming along, and have still to "win their spurs". To hold what we have already gained in the world civil transport markets, and consolidate the field on the other new types coming forward, is a needle question mainly on account of the following:

5.1 A main line civil air transport is a highly specialised form of aeroplane and its design features and constituent parts are all vital to the end result. The accessories, systems, and functional design are relatively just as important as the structure or the aerodynamics. Such a complex piece of engineering cannot be undertaken except by a large firm with considerable financial resources, equipment, and with adequate highly skilled design, development and production staff. When I say "large", I mean large, and in the past we have made the regrettable mistake of believing that a comparatively few capable, hard-working people can attain the desired results on this type of aeroplane. Of course, given time, any qualified person could design, make, and develop a successful prototype, but long before it was finished it would only be fit for the scrap heap, as it would be entirely out-of-date. I am not enunciating that numbers *per se* are the be-all and end-all, but sufficient of the right number and type is an absolute necessity to go quickly enough, and in this respect up to the present, we have failed to appreciate the position.

5.2 Many of us who had the privilege of attending the Anglo-American Air Conference last summer visited one firm that estimates its cost over the next five years for a new trans-Atlantic air liner will be $36,000,000 (£12,857,143) on engineering alone (i.e., design and development) and this sum will be expended up to the time of the certification stage. This figure does not include material or labour costs in the manufacture of the prototypes or tooling for production. I am not suggesting that it would be necessary to spend that same amount of money in this country, but nevertheless I want to emphasise that it is a very big and serious undertaking.

5.3 A successful civil airliner is one in which the objectives have been properly understood by the designers, not merely dictated to them by the customer or the Government. Only by intensified design investigations at the outset can the framework of design be safely laid down, and a basis provided upon which successful development and effort thereafter is possible. This demands superb leadership from the chief design executive, who is accepting an assignment calling for a supreme test of human judgment and control of a considerable engineering staff. He must have all-round knowledge to do this, and be receptive, as well as knowing his own mind. To be successful, he will require an exceptionally well-balanced judgment to guide his lieutenants to make the right decisions all the way down the line.

5.4 One of the big problems confronting our industry is lack of experience in designing for airline operation. In other words, the design groups have not sufficient men who have been through the hard school of experience in this complex business. No technical brilliance can short-cut this necessity of experience, although to appreciate and admit the present poverty of the land will go some way to its adjustment. Because of this lack of experience, few British design teams on civil work possess an adequate maintenance engineering design group. There is also a serious dearth of good mechanical engineers, and it has been common in the past to see excellent conceptions spoilt by bad detail engineering. Often it will be found that these important classes of engineers

are outweighed by performance considerations, and it is not unusual to find structures and aerodynamics dominating the whole team. Such a short-sighted policy, if pursued, inevitably ends in trouble.

5.5 Lack of engineering manpower on British civil aircraft presents a formidable difficulty. Certain post-war projects embarked upon in this country have fallen down, not only because of their lateness in delivery, but in their basic conceptions as pieces of equipment. This has occurred because of inadequate leadership and too small a number of suitable engineers, not only to design the aircraft itself but to cope expeditiously with the whole gamut of component systems, layout of different elements and other various detail installations, which altogether add up to a formidable undertaking. Because of this lack of personnel, far too many compromises have to be taken, and there is an absence of ruthless determination to scrap something which will not " fill the bill ", because of the time factor. Some of these bad habits are inherited from the military side, where such compromises have to be accepted fairly often. Consequently, in the final analysis the mock-up stage is reached too late, and often the mock-up is merely a mockery, representing what is already unchangeable.

5.6 The representative of the airline dealing with the manufacturer is generally a sophisticated person, who is not going to be taken in with rough performance compromises, especially when millions of pounds are at stake. He expects a complete description of the article which is offered for sale, including detailed performance information, presented in such a form that a proper operational evaluation of the machine can be readily made.

Unfortunately, some British firms do not yet seem to appreciate the need for presenting their technical sales data in an internationally acceptable form, which, owing to their immensely wider experience, is another way of saying according to American standards. It is curious how often we rise to this opposition to accept anything American, no matter how good it may have proven to be! We have had to alter our sales publicity and catalogues in many other directions when we have entered new markets already occupied by U.S.A., so that it seems strange that we should baulk over this one.

5.7 Another point where we might with advantage take a leaf out of the U.S.A.'s sales book, is to include thoroughly qualified engineers to act as go-betweens, who can discuss performance and other technical features of their firm's products in full detail. These men should take much of the load off the design office, and save the inevitable waste of time which results from these hard-pressed people going round mock-ups and discussing various questions with a succession of prospective customers and visitors.

5.8 A brief reference should be made to electrical systems and propellers. By the introduction of the latest A.C. techniques substantial savings in weight and all-round better results can be obtained, all of which is fully appreciated. For high power prop-turbines and cruising speeds of over 450 m.p.h., an efficient quiet propeller will be essential. No future large type of transport will be acceptable without

In this group at the reception before the Conference luncheon are ***(left to right)*** **Mr. D. James, Vice-Chancellor, University of Southampton ; Mr. W. F. S. Woodford, Institution Secretary ; Alderman R. R. H. Hammond, Deputy Mayor of Southampton ; Mr. F. T. West, M.B.E., Southern Section Chairman ; and Mr. J. B. Turner, Works Manager, Air Service Training, Ltd.**

such improvements, but it is problematical where we can put our hands on proven British equipment at the present time to meet these needs.

5.9 The production problems of big civil airliners made in comparatively small series have not received sufficient thought in this country. A better break down of the design for jigging and tooling than has been usual is necessary. More component endurance testing than is today standard practice would speed up production. Closer understanding and appreciation of each other's problems between design and production from the early design stages would help considerably ; everything tends to be too rushed and ill-considered because everyone is over-stressed. The production executive must know enough to be able to say when he can release production, and he must be a sufficiently senior and balanced individual for his views to hold full sway. While working as Aircraft Adviser at N.A.T.O. I had an American colleague, who had been Production Manager at a West Coast airframe plant of over 15,000 hands for seven years, and was really knowledgeable on all production problems. After touring the British industry he was shocked at the weakness of some of our production management.

5.10 For the class and quantities of modern airliner production it is most important to pin-point responsibility. A basic requirement is a definite principle of decentralisation. Each superintendent in the set-up must have a clearly defined job. Cost consciousness of all departments and at all levels is essential. The delegation of responsibility all the way down the line to the lowest levels of supervision, and the careful daily checking on this supervision can revolutionise a production plant. It is surprising to me that apparently more consideration is not given to such matters at high level.

For over 30 years I have been going round aircraft and engine factories in most parts of the world, and I am most grateful for the experience this long apprenticeship has given me, in summing up the pro-

duction approach of an organisation. Two or three days' tour of any works, I consider, should enable a thoroughly experienced production engineer from outside the plant to estimate the possible production potential for at least the current work on the shop floor.

The importance of a close watch on realistic charting and scheduling is essential. It is not the obvious big things that count, but the little ones. I am not impressed, if I see a row of dust-coated fuselages, that production is in good shape. Management by exception is a valuable key to production. That which stays on the schedule requires little attention : the exceptions are the things that want watching.

5.11 Quality control, apart from inspection, wisely administered is a great help.

5.12 Enthusiasm and interest for the application of all practical modern techniques are important amongst the supervisory staff, and gadget-mindedness of the rank and file is always useful.

5.13 A modern airliner is a specialised, detailed. complex structure. and it will not just arrive on date by the old shop methods ; it wants a new approach. We possess the right talent for this, but in so many cases it is lying dormant, and it requires time and leadership to bring it out.

6. Apart from these vital questions of adequate defence and civil transport opportunities, the man-in-the-street is beginning to wake up to the fact that holding our place in the air internationally is a definite "must", and is a measure of our virility and creative genius as a nation. In fact, it is realised that it will be impossible to remain a great nation or lead in the industrial and mechanical world markets if a country's aircraft industry is not efficient and up-to-date. The prestige value is incalculable, apart from the air transport field, and affects even the export market of mere mundane things such as socks and washing machines. Aviation and everything to do with it has caught the imagination of the youth of the world, in the same way that the British Navy and Mercantile Marine did at the end of the last century, to the tune of providing the name brands of some of our best-known commodities.

7. Lord Halsbury said, in a recent speech on "Stock-taking on the Research Front", that aeronautical engineering is the most technologically advanced and difficult branch of engineering : and later in this same speech he said that the aircraft industry first tackles, then solves, and finally dominates the solution of problems, which no other branch of engineering would have the incentive to attempt. I believe this to be true, and there is little doubt that the finished aeronautical designer or development technician is amongst the most disciplined and mature mechanical engineers of today, and can adapt himself to any branch of this engineering field with distinction. In support of this, Mr. Heinemann, Chief Engineer of Douglas Naval Aircraft Division, and one of the greatest exponents of the art in the military field, said, at our Anglo-American Air Conference in Los Angeles last June, that on modern aircraft the cost of one pound of extra weight amounts to $500 (£179) per aeroplane, if performance and strength are maintained. In fact, redundant weight literally "costs its weight in gold". Such standards can only be maintained by experienced and matured technicians of a very high order, and we are extremely short of first-class men of this type.

8. Assuming these statements to be correct, it would seem all the more necessary to investigate why we have arrived at this unsatisfactory *impasse,* seeing that from the early days of this century we have successfully pioneered in the design and construction of aircraft, and we finished up both World Wars as the victors, with our aircraft superior in aerial combat to those of our enemies.

9. I would suggest that the end of the last War was a critical time in our aviation history, and although we were nothing like as relatively strong then as at the end of the First World War, nevertheless, by a number of clever improvisations we finished up with a series of successful aircraft from which the last drop of development had been squeezed, while America had built a tremendously powerful manufacturing potential, especially on the military transport side, with an output approximately four times our own.

10. From then onwards, I consider we started to lose our grip. Nobody in their senses would belittle the tremendous effort of the British nation in these two World Wars, especially in the air, and no one will ever forget the immortal deeds of British manpower, which stemmed the over-running of the world by a false and brutal ideology, but we must also admit that for the greater part the powers-that-be controlling our Governmental and industrial aviation policy figuratively sat back ten years ago, and basked in the glow of the successful accomplishment of their War effort.

11. We rested on our war-time laurels, and we did not fully appreciate the implications of the new aeronautical technique which our enemies had assimilated in a most able way, and what a profound change was already on us in everything to do with design and development of aircraft.

12. I well remember being sent over with a team to study these matters by Sir Stafford Cripps immediately after the War, and bringing back by air a remarkable exhibition of new jet engines and rockets, which were set up in London for the aircraft fraternity to examine. I recall at the time many friends and acquaintances being surprised at my enthusiasm and excitement at what I had seen, and I was often asked : "Why are you so excited? Have we not won the War?".

13. The German research equipment, unique at that time but inadequate by present day requirements, was dubbed outrageous and unnecessary, and it was generally agreed by certain senior authorities that they were happy to match the inventiveness of our technicians against the advanced thought emanating from such doubtful extravagances.

14. Those who went to Germany, and had the eyes to see, were staggered at the advances made in research, the scale of their equipment and the number

of trained engineers required to operate these activities. These visits gave some faint glimpses of what was going to happen in the near future.

15. By that time this country, drained to the last penny financially, was fired by well-meaning and, in fact, necessary new building schemes and reconstruction generally in order to lay the foundations of the Welfare State, all of which was delineated in *couleur de rose* by promises of the new Labour Government of a better world to live in.

16. In the flush of victory there was a lack of realisation also by many, that just round the corner there was another potential enemy who had learnt all the tricks of Germany, and for whom the most highly developed Nazi technique was but "mother's milk".

17. We are by nature an easy-going, lazy, nation, and as we won the War so thoroughly, and there were these many other mundane things to be done at home, it was generally felt that we could not wholeheartedly subscribe to the tremendous specialisation of material and mental re-orientation that was demanded to produce these new, slim, swept-wing aircraft of the future. They would undoubtedly come, but all in good time.

18. To be fair, I do not suggest that this was the attitude adopted by all, but it was one which was accepted by about 50% of people affected, especially amongst the non-technical political hierarchy. Take the question of the necessary postwar technicians required alone. It seems unbelievable today that the industry itself stopped that far-seeing man, Sir Stafford Cripps, from building up a nucleus of aircraft designers and draughtsmen in 1945, vehemently saying that they would not be required, and also that it put pressure on him not to set up the College of Aeronautics, saying that it would not be wanted.

19. This short-sighted and uninspired standpoint was pursued for some time after the War, as evidenced in a number of abortive civil types. Eventually we woke up to the true position technically, and although painfully short of research equipment, some excellent design and engineering has been accomplished. The overall picture is nothing like good enough, however, and today we cannot take our proper place in the air with the free nations. In fact, America cannot take us very seriously as an aerial fighting force, although she still has a great regard for our technical ability and engineering capacity along certain lines of aeronautics, but is shocked and bemused at how we have lost ground. As for civil transport, at present we have only got our "foot in the door" with one winner.

20. At the present time our failure in these vital matters is looked upon in certain quarters as mainly due to lack of money and delays on production. It is certainly a lack of a great many things, but not money.

21. It is easy to be wise after the event, and it required exceptional imagination and foresight to appreciate how fast things were going, and that the impetus of this revolutionary new air technique would carry progress on a great deal further in a decade than was anticipated. I well remember that much of the advance information on inter-Continental guided missiles which was brought back from Germany was looked upon as a Jules Verne dream, but many of these projects have already been realised in prototype form in other countries, although we may well still be some way off push button warfare.

22. About 25% of the people employed in all spheres of aeronautical endeavour in this country have, over the past 10 years, worked harder and have devoted themselves more wholeheartedly and selflessly to aviation than ever before, but I venture to say that the remainder have let the side down. Many of them thoughtlessly, through lack of leadership; others have rushed vainly about, both physically and mentally, while the balance have gone the way of the Welfare State and been pretty carefree and idle. Further, on account of that distressing quality of the British of writing down and criticising new things because they are new, and maintaining a blasé attitude of boredom to any enthusiasm on fresh techniques — which is the pith of life in engineering — we have arrived at the difficult position in which we find ourselves today.

23. It was hardly possible for the aircraft industry to escape the general let-up and clammy hand of indifference, and "near enough is good enough" that has gone through this country since the War amongst a section of the workers. I visited many engineering plants in U.S.A. and Germany last year, and I hate to admit it, but by and large their rank and file are working harder than at home. Here again, it would be most unjust to condemn all and sundry, but there can be no doubt that this distressing approach to life has mitigated against our success in aircraft, and the deplorable strikes which occurred in certain of our leading aircraft works during the autumn were symptomatic of the approach of a fair proportion of those who should be responsible to a considerable degree for the aeronautical strength of this country.

24. It appears extraordinarily difficult for politicians and people at ministerial level to understand the intricate set of conditions which have built up during the first 10-year post-war period and have contributed to the set-back in our aviation programme.

25. It is puzzling to know how to set about explaining this very specialised matter to the uninitiated; how far more comprehensive and complicated the design, planning, and bringing to fruition, of a new aviation programme is today, as compared with even 15 years ago.

26. With the object of benefiting from our mistakes, I believe it is necessary to endeavour to allocate some of the responsibilty. As I have already stated elsewhere, however, I would request all those who have this tremendously important subject of our future in the air at heart, no matter whether they are in Governmental service or in industry, to stop face-saving excuses, and adopt a realistic attitude.

27. On the planning side, those responsible for producing new specifications have failed to give industry the right leadership. They have confused long-

Two pioneers of the aircraft industry found much to discuss : Sir Roy Fedden *(left)* with Lord Sempill.

term with short-term problems. The answer is not to try to catch up with America by over-calling our hand, on items on which we have not done the basic research work in order to know if it is possible to produce them satisfactorily. There is certainly no point in writing any requirements into a specification until a proper assessment has been made of the practical possibilities.

28. Since the War, in my view, the secretarial and administrative branch of the M.O.S. has had too much say on general policy and matters outside its legitimate purview. There is a growing tendency for this branch to dominate and vet the technical departments. This is a state of affairs which should not be tolerated either in Governmental or industrial set-ups. It is dangerous if such people express opinions at high level, on matters about which they cannot possibly have authoritative information. This influence tends to frustrate and detract from the usefulness of the technical people.

29. The Government should possess a few first-class highly experienced production engineers who are able to tour a factory and give an adequate assessment in regard to plant, equipment, and what can, or cannot, be done.

30. I am a believer in Royal Air Force personnel taking part in the technical planning in co-ordination with industry, in addition to their present function of formulating Air Force requirements ; but this can only be accomplished successfully if they are experienced, and have spent years on the job.

With modern, complex aircraft, it is unwise for serving officers to be thrust suddenly into a highly technical job for a short spell, and expected to give considered opinions on subjects which are quite outside their experience.

30.1 This matter will never be put right until the whole question of promotion of R.A.F. officers is changed. At present everything is sacrificed to the General Duties branch and the promotion list.

30.2 It should be possible to 'cream off' men at the right stage in their career in the R.A.F. to specialise on engineering and know that they will go to the top of the tree as technical specialists. After, say, 15 years' specialised experience, it would be reasonable for industry to take an R.A.F. officer's opinion on some important technical problem seriously, but with the present set-up both parties are apt to be put in ambiguous and embarrassing positions.

30.3 On two occasions during my Presidency of the R.Ae.S. I was present with a deputation to the Secretary of State for Air on this tremendously important subject of the engineering status of the R.A.F., and although reactions were sympathetic, nothing ever happened because the subject was not understood when it got down to the administrative level. This state of affairs does not exist in the U.S. Air Force. For many years now there have been some highly competent people at the Pentagon, and I would recommend our powers-that-be to study the U.S.A.F. Research and Development Command chart, which has been illustrated and explained in some detail in several technical journals during the last few months.

30.4 Having read Field Marshal Montgomery's recent address to the Royal United Services, I would also recommend that the chart issued by the U.S. Secretary of Defence on Research and Development should be studied by those directly concerned. To initiate the idea of reorganisation is the first step and the easier one, but to bring in courageous experienced engineering administration, which is absolutely necessary, is another matter.

30.5 There are, of course, always several ways of doing the same job, but to anyone with experience of engineering organisation both these charts appear to be practical ways of tackling the difficult problems of technical administration in these Government Departments.

31. Dr. Alexander Fleck, the first Chairman of the I.C.I. Group with a technical background, has recently stated that our greatest danger in maintaining our world export trade is the inadequate scale of pay for technologists in the scientific branch of the Civil Service. This is quite correct, and is a vicious circle insomuch as it affects the scale of salaries in the engineering industry generally.

31.1 Recent recommendations of the Royal Commission on the Civil Service are disappointing on this question, and do not come out strongly enough on the status and scale of pay for senior engineers and technicians.

32. I still believe what I have held to for some time past, that the Governmental side of aircraft procurement must leave the Ministry of Supply and go back to the Air Ministry. At present, the whole Ministry of Supply set-up is too cumbersome and impersonal ever to keep track of such a quickly moving technique as aircraft.

32.1 As regards civil aviation, encouragement must be given to constructors to put up promising forward-thinking civil aircraft designs, and contracts must be awarded for prototypes and necessary development work. Funds should be allocated to the M.T.C.A. for

the supply of these prototypes. These contracts should be managed by the A.R.B. on the administration and inspectional sides. The two Government-operated air-lines should be free to negotiate their requirements with industry without an intermediary. Similar conditions should apply to charter companies and individuals wishing to purchase aircraft.

32.2 The record of the last 10 years does not indicate that the Ministry of Supply has been successful in advising, buying, and generally playing a leading part in the purchase of aircraft for the two chosen instruments.

32.3 Without wishing to be destructive, it is mainly on this account that large sums of money have been wasted on unsuitable civil projects, often wrongly conceived, and by continuing with them long after they have ceased to have any chance of being commercially successful. It is believed that this has been at the root of some of our civil aricraft troubles as much as lack of experience and inadequate engineering strength.

33. I deplore the gradual eclipse of the A.I.D. as a powerful factor in aircraft production, and due, I believe, to pressure for a further reduction in staff, the hierarchy have embarked on a greater delegation of inspection duties. Our high standards in the past, and those existing today, have been built up on the system evolved by the men who devised, developed, and ultimately controlled this organisation.

33.1 Whereas I am sure there are some excellent people in the A.I.D. today, this practice of further delegation may well be dangerous and not in line with the requirements of the much higher aircraft techniques now being developed. Where is the driving force and personality of Bagnall-Wild or Outram? The new family of aircraft and power plant require fresh ideas and new techniques for inspection, rather than working to the old book of words and loosening the grip, at a time when there is a general let-up throughout the whole moral fibre of the nation. Individual responsibility has become a less potent factor today. The need for fearless supervision is greater than at any time in the last 30 years.

34. Government departments can be, and have been in the past, of much help to industry by showing enterprise, leadership and engineering wisdom on a whole host of matters, and by setting up new standards when industry was developing new techniques. In my view the present Ministry of Supply set-up does not permit such an approach, nor is encouragment given to take the lead and blaze the trail in new developments.

34.1 We had such leaders 25 years ago and they played an important part in helping to build up the aircraft industry, but now they either do not exist, or else are not given the freedom to function. Never has there been so much opportunity, however, for this kind of leadership.

34.2 There should be well-established, highly experienced technicians who are able to take up at high level questions of non-delivery, late delivery, failure to reach specifications, and progress payments. It does not meet the Governmental bill to have men who can only check the expenditure of money, but have not got the authority or practical works experience to declare whether there is justification for such expenditure.

34.3 The question of the Break Clause has been a bone of contention for many years, and it should not be used as a means of escape from a bad specification, or for optimistic over-ordering.

34.4 Without any more expenditure of Government money, suitable heads of the technical departments could have been so much more help to industry by searching out ways and means, so that they could write " new bibles " to work from, instead of sticking to those of 20 years ago. This lack of imagination on the part of the Government departments has damped down and kept back the urge for our post-war aircraft.

34.5 More inspiration, leadership and good engineering can and must be forthcoming from the Government technical branches for our Military Aircraft Programme than has been seen in the last decade.

34.6 If the dignity, importance and remuneration are high enough, the best brains in the country will strive to enter this important branch of Government service. It need not necessarily be a large force, but it must be a *corps élite*, and this can only come about if it has full authority, and has complete support from the Secretarial branch.

35. Turning now to a number of technical matters which have held back the production of the new family of post-war British aircraft, these I consider must be laid, to an appreciable degree, at the door of the chief engineers and senior executives of industry.

35.1 Seeing that the aircraft industry is mainly geared to, and dependent upon, a Government department, and is the country's aviation war potential, this necessitates that first consideration must be given to Government requirements, from both national and financial standpoints.

35.2 I would have hoped, however, that a closer understanding between the technical sides of industry and the Government would have prevented that undoubted vacillation and unrealistic policy that has existed in several directions.

35.3 Because of changing political conditions and situations at home and abroad, there is always the risk of cancelled or reduced contracts. This has resulted in nearly every firm accepting all the work it can get, regardless of its capacity to tackle it efficiently, and in a reasonable time. This unrealistic and rather amateurish approach of seizing upon every order possible, has resulted in most firms in the country that have any design team at all being hopelessly overloaded. This is all made more difficult because aircraft design is so much more complicated than it was 10 - 15 years ago, and covers a far wider field of intricate electrical and mechanical equipment requiring first class engineering, and entailing overall a total design capacity of anything from 10 - 20 times the man hours of an aircraft of the last War.

35.4 This in turn has resulted in a few cases in a natural but deplorable state of frustration in the

design team, born of despair of ever being able to get on top of an impossible mountain of work, which tends to leave a design as it is, rather than grapple with a problem only partially solved, and leads to a feeling that somehow or other the prototype will be got right, and in due course production will flow.

35.5 I would date the start of some of these troubles to a Government decision not to allow manned supersonic investigation. In consequence we are at least a generation behind the Americans in fighters, and more than that in the basic knowledge needed to produce Mach 2 machines. Certainly 10 years were lost when it was decided, early after the end of the War, to start high speed research by dropping models from Mosquitos, a plan which was fortunately later abandoned by that far-seeing man, the late Walter Perring.

35.6 Even allowing for the lavish way in which America tackles all design engineering problems, and with the usual 3 : 1 ratio in the numerical strength of their aircraft technical staffs as compared with ours, she still has an advantage of about 2 : 1 over us. For example, for 1,000 British designers, draughtsmen technicians and test staffs, the American minimum requirement would be 3,000 ; but their thoroughness and insistence in tackling every phase of design, aerodynamics, structures, high and low temperatures, electronics, armament research, etc., will double this figure to 6,000.

35.7 One of the mistakes made since the War, but already appreciated by the Germans in the last War, was the " penny numbers " ordered off any prototype. This has been fully ventilated already in Parliament and to some extent remedied, but it should have been appreciated by our technical people and insisted upon long ago. It does not help our current types just arriving, for these can only now be built when production starts.

35.8 I would hope that the recent practice of setting up outside design firms, which has sprung up owing to such difficulties, is only a passing phase and an example of the desperate straits in which the industry has found itself. My personal experience has always been that one cannot get the personal touch or enthusiasm in this way, and that design, development and production supervision in the early stages is the key to efficiency and is largely a matter of inventive thought and effort of a united team.

35.9 British design executives, desperately overloaded for several years, did not in the main avail themselves of as early, or had not the time to investigate, the very real advantages of computer technique as compared with their opposite numbers in the U.SA. There this most important aid to the design and evaluation departments has long passed the novelty stage and has now become a valuable day-to-day tool in the hands of aviation engineers. The field is widening daily at an astounding pace, and without this equipment a designer would be almost as hemmed in as would be the case if he were deprived of some well proven machining principle.

35.10 Introduced originally to relieve pressure of work in the stress department, it has been found of immense value in many other spheres.

35.11 With our shortage of technical staff it is a particularly appropriate item for full introduction into the British industry, and it is hoped that Cranfield College of Aeronautics will be able to specialise on suitably trained staff for this work.

35.12 Up to the beginning of the Second World War, Britain was leading on aircraft materials by a considerable margin. I regret to say I do not think this is the case today. I am not referring so much to titanium alloys, although in spite of Britain having what I understand to be the best production technique for this material, we are well behind U.S.A. in its application. I am, rather, referring to our general approach and leadership on aircraft materials generally.

35.13 I do not consider that this country has kept pace with the available improvements in technique on materials since the War. In the whole material field, where is there a Brearly, Hatfield, Swinden, Julien or Devereux ?

35.14 I am hopeful that Cranfield may be able to play a greater part on materials in the not too distant future.

35.15 I feel that the technical side of the airframe industry, suddenly immersed deeply in fatigue problems since the end of the War, might have got out of their difficulties faster if they had more closely collaborated with their corresponding numbers in the engine industry, who have had this bogey with them for the last 30 years. It is possible it is not yet too late for a closer collaboration !

35.16 After the War, as a result of visiting the first one or two machine tool exhibitions, I felt that this important British industry was forging ahead, but I regret to say that, as far as the aircraft industry is concerned, I am of the opinion it is now falling behind. It causes concern to go round our best engine and airframe plants and see so many new German, Swiss and American machine tools. With the definite changes in type of manufacture that are coming along, this is likely to become still more emphasised.

35.17 In spite of our being supreme in the gas turbine field for the first five years after the War, America has made great strides and is now fairly close on our heels, and I attribute this almost entirely to the great benefit that has accrued from adequate research equipment, based on what we saw in Germany immediately after the War. Vacillation and change of policy has put back our having any full scale altitude engine test equipment. This is required not only for research, but also for early calibration of new prototypes. The tremendous pull that the U.S.A. has over this country on experimental and prototype engine testing is extremely serious. The advantage to their engine industry in having the Unitary plan tunnel at Cleveland for testing the latest engines in the Mach No. range of 2 to 3.5 without in any way interfering with research, is enormous.

35.18 Our Government is tackling this matter, but in too dilatory a way, and it is anticipated that we may have in four years' time equipment comparable with that of the U.S.A.

It is good to know that one British firm has taken on the responsibility of building its own engine altitude tunnel, and will have it ready at least a couple of years before the official equipment is available. In the meantime, other countries are planning even more advanced equipment.

35.19 Similar remarks must be applied to aircraft wind tunnel equipment; although new tunnels are planned by the Government, it is doubtful if they are extensive enough in the high Mach No. range, and there is nothing even thought of corresponding to the two Unitary plan tunnels at Langley and Ames Laboratories in U.S.A., which offer superb facilities for constructors to obtain comprehensive measurements on large scale models without in any way interfering with basic research. Here again, it is difficult to put into words shortly the advantages that will accrue over the next few years as a result of these N.A.C.A. tunnels.

35.20 Cleveland and Ames Laboratories were available for inspection by the R.Ae.S. delegates last summer. No account in these comments has been taken of the comprehensive facilities of the U.S.A.F. at Tennessee or the U.S. Naval facilities at West Trenton.

35.21 In this country, we are at present very cramped by our inability to make the high quality supersonic models required for this advanced work, and this again is a serious "bottle neck". These models are at present taking the best part of a year to make and little can be done on the main design of certain aircraft until the tunnel results are forthcoming.

35.22 It is felt that some designers and a number of Government officials are not yet realistic about these matters; and that *sub rosa*, in the background, there is the old bogey that has been bedevilling us for so long in this country, that we can get by without this class of equipment.

35.23 It is tragic how ineptly this whole question of engine and airframe tunnels has been handled since the War. Firstly, by inferring that they were not necessary at all; and then when at last the facts became apparent, hesitating on the right policy to adopt, and the steps that would have to be taken to meet anything like the required forward programme. We are some way from being out of the wood yet on these vital matters.

35.24 It is tremendously inspiring to see the morale and keenness that can be engendered with facilities such as exist at Edwards Base. With modern supersonic aircraft, which are just round the corner, it is wrong to ask test pilots to do development of new prototypes on certain aerodromes at home.

The attempts to use North Africa have so far been an altogether inadequate stop-gap, and the whole matter requires tackling on a more realistic basis.

35.25 Not all our test pilots have the technical education and subsequent training necessary to deal with present-day flight problems; some of the firms' performance departments are inadequate for formulating proper flight test programmes, and seeing these carried out. Too many aircraft have left the firms in recent years for Boscombe Down, only to be found seriously wanting in their first flights by Service pilots.

35.26 Some of our aircraft instruments are clumsy and heavy compared with those of the U.S.A. Admittedly, there is more opportunity in a greater home market in America with, of course, more competition ; but our instrument makers appear too often to wait and take excessive guidance from the M.O.S. and R.A.E. instead of going ahead on their own.

35.27 I understand that a Committee has been sitting for about five years to decide whether we should have a heavy modern press or not, an absolute necessity for the new integral sculpturing technique. I believe that the members of this Committee who have been standing in the way were the aircraft constructors, who have argued amongst themselves as to whether this is the right way to make aircraft or not. Surely, here is a case where we just could not go wrong by going ahead on one long-term heavy press for a number of requirements, which without any possible doubt will be required. I gather that at last the aircraft specialists are coming round to thinking they want a press, but it must not be more than 25,000 tons. Why this figure nobody knows! I should say one of at 40,000 tons was nearer the mark, seeing that it takes several years to construct, and in view of what I have seen in the States.

35.28 The reactionary irresolute approach of industry on this matter reminds me somewhat of the severe criticism some 20 years ago on our pioneering work on forged cylinder heads and integral milled finning on the score of extravagance, and the fact that in the U.S.A. all heads were cast. For years forging has been obligatory on large high efficiency piston engines, and in the U.S.A. today the most modern forging and integral milling technique is universally used on the engines of all long-range 4-engine transports.

Mr. W. A. Sales, O.B.E. ***(left)*** **Director of Aircraft Production Development, Ministry of Supply, chats with Mr. W. J. Morgan, M.B.E., General Manager, Machine Tool Trades Association.**

36. I feel that the R.Ae.S., which is composed almost entirely of technologists from industry and the scientific branches of the Government, has missed a great opportunity since the War in not giving their members better leadership and guidance to prepare them for this new family of aircraft. I believe it was, and still is, the Society's duty to take the lead in connection with all matters relating to technical education and problems relating to technologists in aeronautics, and to see how, with our limited numbers, our forces can be marshalled and used in a better and more practical way.

37. Turning now to the responsibility of industry, I feel that the S.B.A.C. has failed to appreciate fundamentally the great change that has come about in aircraft technique, and that whereas the Society and all its officers have applied themselves diligently to their tasks, it has for the most part been along the line of the traditional pre-war mould rather than a new approach. By this I do not mean "bigger and better" in the sense of expending large sums of money, but rather an appreciation of the profound changes that have come about, and the need for different tactics.

37.1 Over this difficult post-war time I had hoped that the R.Ae.S. and the S.B.A.C. might have more closely joined forces, and I was interested to see that in the excellent new I.A.S. block of buildings at Los Angeles the trade society had their own offices, and were daily in touch with their technical counterparts to a marked degree.

37.2 Industry, of course, has its many difficulties and problems, and the S.B.A.C., in its 39 years or so of life, has been efficiently organised as a successful trade body, but I think it has got to become a broader and more impersonal set-up than it is at present if we are ever going to get the new types of British aircraft phased, time-wise and technically, to enable this country to have a strong enough air defence force, and a reasonable share of the world's aviation business.

37.3 Pre-war, the industry was a much simpler structure, and by hook or by crook it was possible both to "take in each other's washing", and to have enough work to keep nearly two dozen ordinary members going. I suggest that the greater complexity of post-war aircraft technique may have outmoded this procedure altogether, and that one of the chief problems of the S.B.A.C. is that, while it is serving its members the way they think they ought to go, this *modus operandi* does not fill the bill today.

38. The industry for the most part is controlled by men who came into it in its early wood and fabric days, and it must be immensely difficult for them, having lived through two Wars, and done a very fine job of work, to adjust themselves to the modern requirements with a vastly different tempo; in fact, I should think it was quite impossible for them to do so.

38.1 Some of the aviation pioneers are doing a disservice to industry by throttling their firms, because they want to keep everything in their own hands, be it design or top management. In consequence, little promotion takes place, either for experienced or promising personnel, which results in the technical and administrative strength of the company being stultified.

39. The British aircraft industry should be a dignified world-wide institution,, and however well its leaders have served the country in the past, it is submitted they have not shown sufficient leadership since the War to meet our needs by debunking tradition where necessary, and facing up to facts in regard to the volume of work that can be executed in a given time. Also, for the most part they have failed to spot and bring on the right executives and lieutenants to succeed them.

40. Whether we like it or not, industry has got to make the best of the leaders it has got for the time being, but it should insist on them realising that things cannot go on as they are, or in a few years from now British aviation will count for very little indeed. Those holding the reins today must face up to reasonable rationalisation to meet immediate needs until an entirely new plan for the future can be worked out, entailing fresh leaders and a different production technique.

41. I believe we have too many major aircraft firms and too many projects in the military field. Everything is spread too thinly, particularly in the technical and engineering departments. There must be rationalisation, combination and concentration on a few vital projects. In the process of pruning we must ensure that those projects which are retained are the ones most needed, and once settled there must be no further looking over the shoulder. A few selected types executed properly will prevent the present waste of time and money and get us somewhere, and stop us drifting.

42. Sweden outstandingly, and also Canada, are examples of countries that knew what they wanted, made reasoned and definite decisions, and saw to it that these were carried through without all the vacillations we have seen here in the last decade.

43. If we take the United States as our yardstick and compare the size of their aircraft industry and the range of types in manufacture, it is obvious that we are either incomparably more efficient, or we should not be attempting to do so many jobs.

43.1 We have on hand today twice as many aircraft as it is possible for us to undertake and phase into production in time to avoid obsolescence.

43.2 In order to concentrate our efforts and work efficiently it is suggested that we should do better with three main engine firms and six airframe constructors. This suggestion would not embrace the smaller ranges, including feeder, training, and personal aircraft and engines.

44. This all sounds like an extremist view that things are bad indeed. Let us be honest. They are certainly very bad, but not hopeless; although they will be in a few years' time, if it is thought possible to get back on to the top line, and keep there, by making no more than minor adjustments.

44.1 Why I believe it is possible to be hopeful for the future is because of the nucleus of trained,

disciplined engineers with unbeatable creative and inventive capacity, that exists in Britain today.

44.2 So far it has seemed impossible to find enough of these men, and two of the factors which have stood in the way are :- The missing generation of World War I, and the big expansions in other engineering industries, again without the foresight and long-term planning for trained personnel.

44.3 But I believe time will produce the men, and given the opportunity and right encouragement, the necessary executives will be found, possessing original, vigorous and courageous thought. This will not just happen, however, and something has got to be done about it.

45. I would here like to refer to the coming of a new set of conditions in the construction of future aircraft which will entail profound changes in the whole approach to manufacturing problems. It is impossible to do more than touch very briefly on these matters, as each facet—and there are many—requires a Paper on its own. They are, however, to me, very exciting and provide another reason for being optimistic for the future, as I feel they fit exactly into our British philosophy.

45.1 In the future the number of first-class aircraft, whether military or civil, which we shall have to build will be in smaller batches and they will become more and more of a traditional engineering structure. At first sight, if we follow out the prevailing very expensive tooling technique so successfully and lavishly expounded in the U.S.A., these changes would seem to indicate a serious further setback for us, and it would appear as if it would be more difficult than ever to keep our end up on this new family of aircraft. The tooling costs would be stupendous, and might rule out any prospect of Britain embarking on production of these types, if traditional methods had to be employed.

45.2 But if it is possible to envisage production methods undergoing a radical change by the introduction of a new technique, greatly simplifying or eliminating this serious tooling bogey, then an entirely new vista might be opened up which is not only well suited to these advanced aircraft, but would also be practical for short batches, reduce the lead time in the production of prototypes, and exactly fit into the philosophy of the traditional British craftsman.

45.3 This all sounds idealistic and too good to be true, but you have already heard a Paper on lofted templates in the place of drawings, and this practice is growing and will materially assist matters.

There was also another Paper two years ago at this Conference, when it was explained that large complicated machine tools are not necessary for the production of bulky components in light alloy, and that simple tooling can be used. Heavy duty routers employing rudimentary locating fixtures and templates will produce complicated sculptured components, and the templates themselves can be readily made on specially designed machines.

45.4 By further extending these proven methods, and by introducing the automatic control of the machine tools employed by suitable electronic means, the possibility is afforded of producing one off components, or batch quantities of items of a complicated nature, in a simple way.

45.5 The part to be manufactured will have to be described either numerically or mathematically, and the information coded and fed into the director control of the machine tool. These coded directions are interpreted in the form of electrical pulses, which control the servo motors operating the machine tool slides, thus bringing about the guidance of the workpiece, or the tool. Of late a great deal has been heard about automation, a word which is not yet in any dictionary, but soon will be. The use of numerical or automatic control for machine tools, which has just been described, does not properly come under true automation. For simple two-dimensional regulation of machine tool slides or for drilling by co-ordinated means, numerical control by the use of teleprinter tape is possible.

45.6 There are many approaches to the electronic control of machine tools, and it may well be that eventually standard kits of parts will be on the market at reasonable prices, which will enable the conversion of standard machine tools in order that they may accept punched teleprinter tape for automatic control. Tooling will then resolve itself into the simplest of fixtures for the accurate location of the work, and the provision of a punched tape which has been produced on teleprinter punch machines or telewriters from numerical data supplied by the Planning Office.

45.7 This approach will enable a large variety of two-dimensional milling work, complicated programme drilling to close limits, the production of turned parts and other machine shop operations to be carried out with a minimum of tooling, and with unvarying accuracy. The introduction of this system will inevitably reduce the lead time in the manufacture of new prototype aircraft and will materially assist in reducing costs and times in full scale production.

45.8 It is, therefore, of the highest importance that this interesting new technique should be pushed on as energetically as possible, as it would seem that we could excel in this type of construction, which fits in so well with our training and engineering background.

45.9 The disturbing feature, however, is the attitude of the machine tool manufacturers to this new conception. As far as I am aware they appear to be doing little about it, and I understand that the research into numerical control which is going on in this country at the moment, is mainly in the hands of firms other than machine tool makers.

45.10 Turning now to the future position of the aero engine industry, in comparison with the considerable output required during the War, and also during the recent expansion on account of the Korean emergency, we are faced with relatively small production runs of large gas turbine engines. With the increase in complication of the larger turbines, these small numbers, if made with the traditional elaborate tooling, would involve a serious manufacturing problem. Therefore, the great need at the moment is

for an increased flexibility of manufacturing methods, and the problems to be faced are in some ways akin to those which have unfolded on the airframe side.

45.11 Flexibility of machine tools in the production sense is only coming about slowly, but in our most modern aero engine plants today we are seeing, in increasing numbers, standard machine tools with control mechanism which enable the machine either to repeat settings or to follow a given contour. For the most part these are horizontal and vertical borers — the latter with automatic tracing devices — and jig mills. It is with regret that it has to be recorded that practically all these machines come from abroad. There is a considerable demand for this type of plant for a large variety of purposes.

45.12 Machine tools which are controlled by means of a series of instructions prepared from a computer are also just beginning to come into aero-engine plants. Here, again, it must be admitted that we in Britain are not leading on these important types of machines, but they will undoubtedly play a large part in the new type of aero engine manufacture, when the control equipment has been fully developed.

45.13 It is generally accepted that automation in the varying categories of engine shops throughout industry applies chiefly to the large volume production of automobile power plant. While the more spectacular and obvious applications will undoubtedly show to the best advantage in this class of high volume industry, there is still room for the development of items coming under the heading of automation in the batch production industries such as aero gas turbines.

45.14 The greater portion of production, however, in this country is on the batch principle, and it must not be forgotten that it is one of the most complex types of manufacturing. Frequently, examples are seen where the actual tooling and cutting equipment on the machine tool is first rate, but the manner in which the work is brought to the machine and loaded into the fixtures before the operation, then removed from the fixtures, and taken away after the operation, seldom receives any consideration. There is a great field for the application of automatic handling devices in this kind of batch production. This is going to tax the ingenuity of the automation engineer because the essential features of devices of this nature will be that in themselves they will require flexibility, as they will have to deal with successively difficult components. Their cost therefore can only be justified if they can be used on a number of different jobs.

45.15 We are undoubtedly going to see important changes in inspection methods, including electronic testing devices, as well as the further expansion of non-destructive testing, and some of these may prove to be the precursor of further automation.

Here, again, from a recent tour in Germany, I gather that several of their firms are very active in these directions.

45.16 It will therefore be seen that there is an important and exciting new field of production techniques for the comparatively small quantities of future airframes and aero engines, which we may expect to be coming along in the not too distant future, and instead of having to face unsupportable costs for extremely expensive tooling, we can anticipate the sort of production costs which are within our scope, and suited to the type of production engineer and craftsman we have so successfully produced in the past. It is, therefore, up to our managements to seize on to these opportunities and produce the right type of aircraft, and for our production engineers to collaborate with the electronic and machine tool industry, energetically and quickly.

It may well be that the aircraft people will have to design and develop their own machines, which I believe is already being done in certain instances. It is, however, of no use to talk about these innovations as far-off research possibilities; let us grasp this opportunity to employ the sort of engineering which has for so long been our birth-right. There must be more development effort expended on production techniques, both by the Government and industry. Up to the present time this country has spent little on development for production as compared with design.

46. When all is said and done, we come back to the basic fact that the nation's needs in aircraft are not being met today, mainly because we have not got sufficient of the right type of trained men to organize and control this extremely exacting but enthralling business of aircraft engineering, which embraces all forms of air defence and air transport.

46.1 In the final analysis, therefore, as in nearly every other human problem, it is the man who counts more than anything else, and it is right here that our greatest hope lies, because we know we have the correct material in embryo, if only we have the courage and clear-thinking to spot and bring on the talent which is already there lying dormant, and take steps promptly to train sufficient of the right type for the future.

46.2 Last year the Press was flooded with articles and reports about Britain's shortage of engineers and technologists, and there were many schemes put forward as to how the matter was going to be tackled. At long last, therefore, the nation should by now be aware of the sober fact, which is as simple as this: that if this country is going to survive at all as a great power, something must be done about training a greater number of first-class engineers and technologists of ability very quickly indeed.

46.3 I have the uncomfortable feeling that comparatively little has yet been done about this matter beyond a great deal of talking, and I am not convinced that the powers-that-be are certain of the best way of tackling the problem. Although quality is always more important than quantity, I still think we are light on our estimates on the number required. It is officially stated that the gap between supply and demand of engineering graduates is 25%; I suggest it is about 33%, and may grow even more unless something is done about it promptly.

46.4 What the aircraft industry has to ensure is that it gets its fair share of the right type of those who are coming forward for training. We must be thankful that the aircraft industry is a good deal more

enlightened on training than any other branch of engineering, and that a number of firms have well-established apprenticeship schemes and technical training departments. But it is not doing enough, or going fast enough on training, and it is shorter of first-class production engineers probably more than any other category, and has not yet, in my view, evolved an entirely satisfactory curriculum for training production engineers.

46.5 Let us consider for a moment how aeronautical technicians and executives were provided in the past. A very small number indeed had the advantage of a university degree. For the most part they came up the hard way ; either by Matriculation or later on by Higher National Certificate, or an apprenticeship with part-time work at a Technical College. In fact, one might say that most of them were amateurs, who had graduated by the light of day, hard work, earnest endeavour and common sense. Our production people, until a few years ago, were selected in an even more haphazard way, and were mostly from the shop floor.

Many of our most brilliant successes amongst design, development and production executives in the past were engineer enthusiasts, i.e. amateurs who had been recruited into these categories, and had the great urge to go into this new line of engineering, were willing to work very hard, and possessed courageous thought and leadership.

46.6 I think we are all agreed that the size and importance of the industry today, the tempo and complexity of modern supersonic aircraft and gas turbines, with all their many facets, demand a more highly developed type of individual to fill the leading posts in industry. This is far too broad a subject to attempt to discuss in detail today, but here are a few suggestions on matters which will help the supply of more suitably trained graduate engineers :

46.7 Incidentally, while we are on the subject of training engineers, it would be a good thing if the terminology and definition of the different classes of engineers were once and for all settled, and if the U.S.A. and ourselves could come to an understanding on this matter it would be even better.

46.8 Starting at the very beginning, we must tackle the poor quality of basic education given to school children today. There is too much experimental work going on by crank psychologists, and what is wanted is sound rudimentary teaching without so many freak trimmings.

46.9 The failure of National Certificate students to meet the requirements in the higher supervisory categories in modern precision mechanical engineering has led to the expansion of sandwich courses, comprising alternate periods of up to six months, of full-time college attendance, combined with industrial training. This scheme seems to be working out very well indeed, but wants widening considerably.

46.10 It would seem that there are a number of late developers with latent engineering ability who, if they were allowed to stay at school another year, might prove quite useful technicians ; it is stated that there are anything up to 5,000 boys per annum in this category who, if they were allowed to stay at school until 18, could become an important asset, in order to help the present shortages. I gather that of sixth-form Public and Grammar school boys, considerably less than 50% are taking mathematics and engineering as their advanced subjects, and a marked change must be made in this percentage if the number of outstanding engineers and technologists is to increase materially.

46.11 To fill immediate short-term gaps I suggest firms might devote more time to talent-spotting from their present ranks. I am of the opinion that there is appreciable latent ability existing today which a small enthusiastic expert panel could discover and which would respond quickly to special courses.

46.12 An urgent need in the aircraft industry is obviously the training of a modicum of first quality production engineers. These should be men of ability with a good general engineering and technical background. At present, I suggest, this matter has not yet been tackled in a broad enough way, and a top-grade production engineer needs a wider technical and practical background than most other branches of the engineering profession. A Production Engineering faculty consists of much more than a small Machine Shop with a lecturer and one or two demonstrators.

46.13 I would recommend those interested in the training of production engineers to study the report on "A Six Months' Observation of the American Methods of Training in Industrial Engineering and Management in the Universities and Industrial Plants" prepared by Mr. T. B. Worth, Assistant Head of the Mechanical and Production Engineering Department at the College of Technology, Birmingham. This was undertaken at the request of the Ministry of Education, and it shows the pattern of industrial engineering training given in a four years' course. It is interesting to note from this report, that the percentage increase of students in industrial engineering in the States between 1940 and 1950 is 376% as against 15% in mechanical engineering, and 168% in chemical engineering.

47. From a short study I made last summer of engineering training in the U.S.A., it would seem that America is about as far ahead of Britain in training production engineers and supervisors from the senior executive to the foreman, as we are ahead of America on apprenticeship and craftsman training for the mechanical trades.

48. It must be faced that there will be little improvement in the whole question of training engineers until the position of suitable engineering teachers has been corrected, both as regards status, numbers and salaries. This is a matter of prime importance, which can no longer be shelved, and is, I understand, a world wide problem today.

49. A new fund sponsored by 17 of the largest industrial concerns in the country and guaranteeing over £1½ million to make suitable grants in engineering education is a step in the right direction, but it is highly important that by the time these grants have been put into practical effect, there is a sufficient supply of really first-class teachers and the right

quality students. This shortage of good engineers, who are the very lifeblood of the aircraft industry, must be dealt with by giving sound advice to parents and teachers on the opportunities that the profession offers, and we must ensure that the opportunities are real, in every sense of the word, and not mythical.

50. In spite of all the difficulties and problems that undoubtedly exist and have to be solved in this country in order to get enough of the right type of young man for aircraft engineering, I feel we shall not be successful in the long run unless there is an absolute about-face of the whole nation, regarding the importance of all branches of engineering, and particularly aircraft engineering, for the coming generation.

51. Let us be frank about this ; it is still not " out of the top drawer " to be a mechanical engineer. The scholastic hierarchy from our senior schools and universities have for some long time accepted science, and now give lip service to engineering as an accepted profession, but by and large, still do not believe it to be so in their hearts. In actual fact, it is first-class engineers of high ability recruited from the right background that this country needs so badly.

51.1 I was astounded, when I was working for Sir Stafford Cripps on the preliminary negotiations for the setting up of the College of Aeronautics, and had to visit a number of his colleagues on his behalf on this matter, how strongly these old traditions prevailed, even amongst many of the most eminent men in the Government of the time.

51.2 I therefore propose to devote the rest of my comments on education in an endeavour to help debunk these " dyed in the wool " fallacies.

51.3 Mr. George Constantinesco delivered a classic lecture on this subject before the Society of Engineers a few years ago, and I propose to quote a few of his comments :

" It is difficult to give comprehensive definitions to distinguish between the scientist and the engineer. Both of them use science, only in different ways ".

" Early scientists like Plato and Aristotle had their own ideas about master and slave relations, which made them rather contemptuous towards the mechanical arts, which, according to the doctrines of their time, were dishonourable ".

" What are called the mechanical arts carry a social stigma and are rightly dishonoured in our cities " That was a good shot by Xenophon against the engineers of his time (430-355 B.C.).

" This old cleavage between pure science, as scientists like to call their domain, and the practical science which by contrast is the domain of the engineer, exists to this day, only in a slightly modified way ".

" To argue that engineering is the product of applied science is not correct. Engineering is the product of knowledge of all kinds of skill, perseverance, imagination, faith, sacrifice, fanaticism, invention, war against human toil, and unfortunately often war against the scientists ".

" And why is it called the Science Museum? Why not Engineering Museum?"

" The keynote of most of the exhibits in the Science Museum is the faith of inventors who used their knowledge and engineering skill to illustrate and achieve something new in spite of the science and the scientists of their time ".

" One fears that the reason is to be found in the old lingering tradition that practical science is inferior to pure science, that people who work with their hands are inferior to people who work with their brains ".

" This is the doctrine that was alive at the time of Pythagoras, Plato and Aristotle. It is just as well to realise that this doctrine is not dead by any means ".

" Scientists are not superior to engineers. Scientists, engineers, pioneers, inventors and all, are but children of nature looking from different places and in different circumstances at the same problems ".

" This barrier between scientists and engineers could be lifted by training both of them at the same school. A start has been made at the University of Durham to introduce humanities into the training of engineers ".

" Eventually scientists and engineers should merge into one single qualification of men with one single purpose to work together for the good of everybody ".

51.4 Commander G. Penn's recently published book entitled : " Up Funnel—Down Screw " brings out excellently the long fight the Naval engineer has had to come into his own. The improvement in the status of the Naval engineer has been a comparatively slow one. It has taken about two normal lives since the Captain of H.M.S. ' Alban ' ordered his Chief Engineer to be flogged when he had trouble with his engine, to the time when it has been publicly stated that Naval engineers are " all first and foremost Naval officers ". Only during the last few months has the Naval engineer shed the " E " stigma, which has been with him for so many years.

51.5 For generations past the most promising British up-and-coming stock has been led to believe that by taking a classical education, they were equipping themselves most suitably for the most interesting and best paid professions, and that, by and large, these did not include engineering.

51.6 We can correct the many other anomalies that exist today and take the necessary steps to provide adequate facilities to train the right type of engineer for the Services, Government departments and industry; but one of the most important things to help on the production of our aircraft on a long-term basis is to eliminate this stigma on engineering as an outstanding profession.

52. What then are we going to do for the future to meet the urgent needs of the nation for aircraft? Sir Winston Churchill wrote in his account of the last War, that under such circumstances, the great thing to remember was the overall objective. Are we really quite clear what this is as applied to our particular problem? We certainly cannot afford to leave things as they stand today, 10 years after the War.

52.1 It seems to me our main trouble has been that, with a few notable exceptions, neither in the Government nor in the British aircraft industry has it been realised what vast opportunities would be available during these 10 post-war years. For the time being we have lost the courageous leadership and the burning spirit to succeed at all costs.

This failing is only symptomatic of where the country stands today in many other respects, and it would seem that after a civilisation of as long standing as ours wins a major war, the tremendous effort which has been put out is followed by an impoverishment of initiative and fresh endeavour. This results in a whole crop of well-meaning but ill-considered regulations coming into force which are exploited and abused with disastrous results.

We must take a stand to prevent this weakness eclipsing a young and vital industry such as aviation, and everyone in Government service and industry, including the youngest of you present here today, all share in some measure the great responsibility that exists, to contribute towards putting this matter right with the least possible delay.

52.2 Let us, therefore, go back to work from this Conference realising that everyone, however humble, can make some contribution, and that we must no longer accept excuses or words, but must be determined to have deeds.

52.3 As I was writing these notes a few days ago, I received a copy of Lord Hives' Christmas message to his workpeople in which he said that he believed it was worth fighting hard to preserve his Company's reputation in the coming year. Knowing they had the knowledge, the skill and the resources if they would preserve a spirit of goodwill and willingness to help others, he was confident for the future. This is the spirit which wins out! It is our very lifeblood for British aviation to fight hard.

Some firms, however, are better situated in regard to leadership and knowledge than others, but, by and large, I believe the potential resources are all available in this country to meet our needs in aircraft, if only everyone will courageously "put his shoulder to the wheel" and not let up. So far, however, in my view we have hardly made the first move on the fundamental issues.

53. I wish to express my grateful thanks to those of my friends and old colleagues who have been good enough to give me valuable assistance in compiling this address, and reading the proofs.

REPORT AND DISCUSSION

The **Chairman,** opening the Conference, said: "Last night, when owing to the fog I became completely immobilised and had to abandon my car in a suburb of London, I wondered whether I should ever reach Southampton today and indeed whether anyone else would do so. You can imagine, therefore, how delighted I am to be here and to see such a large number of you here, all eager for the fray and looking forward with enthusiasm to the next 24 hours.

"I am also delighted to be here because this is a very special occasion indeed. It is a special occasion for you, and that is one of the reasons why so many of you are here and why this Conference has been over-subscribed, and it is very delightful for me, because one of the privileges which a Past President of this Institution enjoys is on an occasion such as this to act as deputy in the unavoidable absence of the President. I cannot think of any more delightful duty than to take the chair to honour an old friend and colleague, Lord Sempill.

"As you know, one of the ways in which the Institution endeavours to honour its prominent members is by naming a Paper after them before they are dead. We have already named two Papers after very prominent Past Presidents of our Institution: Lord Nuffield, who has had so much to do with Lord Sempill, and Sir Alfred Herbert. This is the fourth Aircraft Production Conference to be held at Southampton. I shall let you into a secret. We decided that it would take at least four years for this Conference to reach the eminence which it has now attained, an eminence which would enable us to ask Lord Sempill to allow his name to be associated with it.

"I think I can say that this Conference is one to which the aircraft industry eagerly looks forward, at which wise words are said and which is likely to be continued over the years and which I hope will continue to be held, in accordance with the invitation of the Vice-Chancellor, at the University of Southampton.

"We felt, therefore, that we could approach Lord Sempill and ask him whether he would do us the honour of letting us name a Paper after him, to be read each year at Southampton at this Aircraft Conference. We are honoured that he has allowed us to do so, and we hope that the Lord Sempill Paper will continue as the years go by to be an ever more successful (if that is possible, in view of this year's author!) venture on the part of the Institution. I am sure that it will stand high in the annals of production engineering and of the aircraft industry generally,

"What can I tell you of Lord Sempill that you do

not know already ? Sir Roy Fedden, in the foreword to his Paper, says a great deal about him. Sir Roy says that he has known him for the last forty years. I have known him for only fifteen years or so, but my memories and yours of Lord Sempill — the Master of Sempill, as he was known earlier — go back many years. We know him, and the general public know him, as a pioneer in the aeronautical industry, as President of the Royal Aeronautical Society, and as a man of wide interests and sympathetic understanding. Not only do we know him in connection with aeronautical engineering and the aircraft industry, but those who have followed his career in more recent years will know that he takes a lively interest even in such subjects as jam and the colour of kippers. A man with such a wide range of interests is a lucky man, a distinguished man and a very happy man to know.

Lord Sempill and the Institution

" What about our Institution and Lord Sempill ? Most of my memories of Lord Sempill are connected with this Institution. I well remember him, many years before the War, as President of the Institution, and I remember the influence which he brought to us on that occasion. He was largely responsible, for example, for getting Lord Nuffield to act as President and for Lord Nuffield making to the Institution the very handsome gift which has stood us in such good stead since. I remember, however, not only those pre-war years, when Lord Sempill did so much for our Institution, but the war years and the post-war years. Although Lord Sempill walks among the mighty, one of the things which has endeared him to me and to many others is the way in which for many years he has presided over our Library Committee, where he has had the opportunity to guide and give inspiration to some of the younger members of the Institution. That has endeared him to many of our members quite as much as the great things which he did for the Institution as its President many years ago.

" I personally owe a debt of gratitude to him. Every man who is on his way up, even if he does not get very far, can usually look to a few people who have helped him and given him the benefit of their experience. I have had more help than perhaps I deserved from Lord Sempill, and I should like to use this occasion to express most sincerely to him my personal gratitude.

An Aircraft Pioneer

" From a personal point of view, from the point of view of the Institution and from a general point of view, therefore, we can feel that we have very worthily named this Paper, and I am certain that it is going to live up to the traditions of Lord Sempill himself. How is it going to start such a tradition ? Lord Sempill could not have found anyone better qualified than Sir Roy Fedden to start off this Sempill series, and in fact Lord Sempill chose him to do so.

" What can I say about Sir Roy Fedden that you do not already know ? At least one thing that very few others here can say, and that is that I, as a young apprentice, knew him nearly forty years ago. At that time I used to watch his stalwart figure, clad in winter in a very long overcoat, stalking through the factory, and as a young and timid apprentice I felt that this was the boss, and that it was a pretty good firm — as it obviously was, because Roy Fedden was in charge of it. Later on I began to realise the great things that the company and Roy Fedden and his design team were doing in developing the Bristol range of radial engines, which led the world and established him as a pioneer.

" He has been a pioneer in the aircraft industry. He has also been something of a stormy petrel, a man who has always said what he thinks, and in vivid language, and who has not been afraid to say it in the seats of the mighty. In that sense he may sometimes be regarded as a man who has criticised a great deal, but he is a man who has also done a great deal and who must be listened to when he criticises. In the Paper which he is now going to present he is perhaps critical, but we must remember that he speaks from a great fund of knowledge and achievement. It gives me great pleasure to introduce him to you."

(*Sir Roy then presented his Paper, which appears on pages* 140/155.)

The **Chairman** remarked that the brilliant light in which they were bathed, which was due to the fact that the B.B.C. were recording the proceedings for the benefit of posterity, reminded him of the man who thought that " B.B.C." stood for " Better be careful " and " I.T.A." for " I'll try anything ". On the present occasion it could safely be said that Sir Roy had certainly not been careful, and it might also be said that he had tried everything and condemned everybody. At the beginning of his address, however, Sir Roy had said that the patient was still far from well, and had asked : " I wonder if a little shock treatment might help ? "

On the present occasion the audience represented the patient, because they represented the aircraft industry, though naturally they belonged to the 25 per cent. that Sir Roy said worked so well, and not to the other 75 per cent. The fact remained, however, that they represented the aircraft industry, and that whatever section of the industry they represented Sir Roy would have said something constructive about it. They now had the opportunity to say something constructive in their turn and to contribute to the general theme of Sir Roy's brilliant Paper.

The discussion would be opened by Mr. Hollis, who represented those " frustrated Ministry of Supply technical types " referred to by Sir Roy, and he would be followed by a " machine tool type ", Mr. Chambers.

Mr. W. S. Hollis, B.Sc.(Eng.), A.F.R.Ae.S. (*Assistant Director, Aircraft Production Development Directorate, Ministry of Supply*) said that they had listened to a great deal of commonsense. The Paper put forward, in a succinct manner, a great many home truths, and all must admire Sir Roy's perception. The Chairman had said that Sir Roy spoke from experience ; the deeper their own experience the more they would wish to pay tribute to the truth of Sir Roy's judgments.

Sir Roy's remarks on the civil aviation side were largely true, but Mr. Hollis thought that it was not entirely the designers who were at fault ; the conditions were governed by the changes due to the forward planning of the operating lines, which in turn affected the designer. It might not be possible for the designer to accept the bolder constructional methods which the project engineers would like to recommend. Firms engaged in civil construction had to provide their own economy and must inevitably adopt a flexibility in methods to provide for the changing circumstance. The solution was to believe in the nation's competitive ability in design and construction and to determine to produce what was thought best with a sense of urgency.

In the matter of large integral construction methods, Mr. Hollis believed that at one time Britain had a lead in thought over America, who had been preoccupied in terms of large forging presses of 80,000 tons. It was realised here that it would need up to 40 tons/sq. in. specific pressure for forging strong light alloys, so that forged integral wing panels were out of the question altogether. There was no doubt that greater flexibility of application could be achieved by producing slabs which would remain dimensionally stabilised after machining, and that stretch stabilising should be recommended to secure this. Certain firms had been anxious to adopt stretch stabilised slab, others had not been so sure about it, due to the lack of a background of experience. It had, therefore, taken roughly three years to obtain that unanimity of opinion which made it possible to approach the Northern Aluminium Company with a sufficient guarantee of use to take the risk out of the speculation and for them to go ahead with the provision of stretched stock. The Americans, however, with their usual directness, had recognised their omission and provided stretch level presses, first of 1,500 tons and then of 4,000 tons. The latest, he was told, was 15,000 tons, as against the projected press in Britain which might be of 4,000 tons or perhaps as high as 6,000 tons, and for which it would probably be necessary to wait another eighteen months. In this country there ought always to be a sense of urgency in deciding what to do, and where there was a question of adopting one method or another, the thing to do was to use both and go ahead until the position was resolved ; it was cheaper in the long run, whether measured by technical advance or the order book.

He would like to enlarge on the statement in para. 45.4 of the Paper, concerning the suggested combination between the ' lash-up ' and electronics. He might have misunderstood the Author, but in order to give a fuller explanation it should be said that no one wished to make a machine tool complicated or expensive for the sake of impression; if an impression was given it would be a bad one in any case. However, low friction slideways and motors with high torque/low inertia ratio, with the means of obtaining reference to the original datum position, were essential on any servo system giving accurate reproductivity. This was unlikely to be found in rudimentary equipment typified by the lash-up housing which had had to be used from time to time to get production and yet avoid spending a lot of money on production methods.

The machining rig was suitable for special purpose applications and was undoubtedly the best way to provide the manufacturer with a flexible means for dealing with the unusual. It was in precision machining, however, that electronics would show to the greatest advantage in the saving of skill, and naturally precision machining was tied to the precision machine tool with accurate slideway, the precise movement and precise method for measuring this movement for the cancellation of signals in the servo system. It called for robustness in machining heads, the columns and so on. To clear up the point made in the Paper, electronics would be chiefly a means of actuating rigs or rejuvenating old machine tools.

Precise methods of electronic control would have to be developed and used in connection with the complex machine tool. That fact had been recognised, and Ferranti and E.M.I. were co-operating with the Ministry of Supply in producing the right equipment. The American machine tool industry were undertaking similar work, and had been more astute and definite with exploiting their M.I.T. system. Mr. Chambers, who kept himself fully acquainted with development across the Atlantic, might be able to show the Conference where the Americans had used electronics and how they had gone ahead, while this country had proceeded more slowly.

Mr. H. A. Chambers (*General Manager, Rockwell Machine Tool Co. Ltd.*) said that they had all very much enjoyed the Paper and would all agree that the Author was eminently qualified to put forward the point of view which he did. The Author had been critical of the aircraft industry, the Civil Service, and the machine tool makers of this country, and it was to be hoped that his views would be listened to with attention.

Mr. Chambers wished to show a few examples of what was being done in the United States of America. Reference was made in the Paper to automation and electronic control, and it was important to know what other people were doing. A year ago he had said that the U.S.A. had ten years' experience of modern machine tools for use in aircraft construction which Britain could have for the asking, and he had asked whether this country could afford to ignore this. He was still of opinion that they could not afford to do so. They must not bury their heads in the sand and think that they could do better than anyone else. They had brains and they had ability, but they were short of money.

When the United States Government were faced with the problem of constructing advanced types of aircraft they said to their aircraft industry: "You must get together and decide what you want. Money does not matter; whatever you decide on you shall have." The machine tool industry of America took note of this and designed certain prototype machines to be tried out; some were successful and some were not. Eventually they decided that they would make a particular type of machine and adopt it as a standard. They made 20 machines, each of which was better than its predecessor, and they had now produced a machine which was electronically controlled and which was entirely automatic.

The British machine tool industry had been criticised, but if they had had the same opportunities that the American Government had put before the American machine tool makers they would not have been found lacking. The position today was that the American Government had placed an order with the machine tool industry of the United States for 20 skin milling machines and 15 Variax machines. How many million pounds that represented he did not know, but it would enable the aircraft industry of America to go ahead and to make their component parts much more quickly and cheaply than they could be made in this country.

He did not claim to know anything about aircraft, but he did know a little about production engineering. The wing skin of an aircraft could, he believed, be made in one piece. If it was fabricated, he understood they would need 1,500 component parts and 6,000 rivets. Every single rivet seemed to require a piece of paper, and if one lost the piece of paper one lost the rivet. There should obviously be the possibility of a very big saving there.

(Mr. Chambers then referred to the photographs reproduced here).

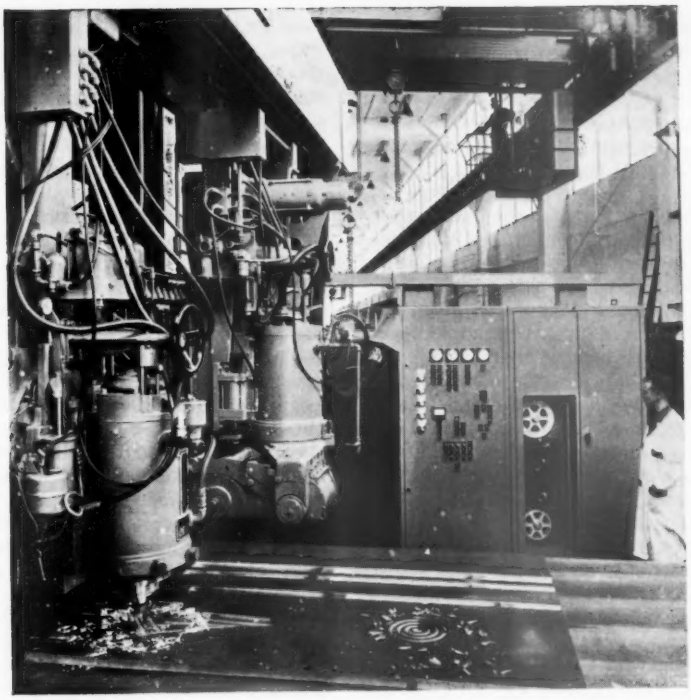
(Illustrated top, right)

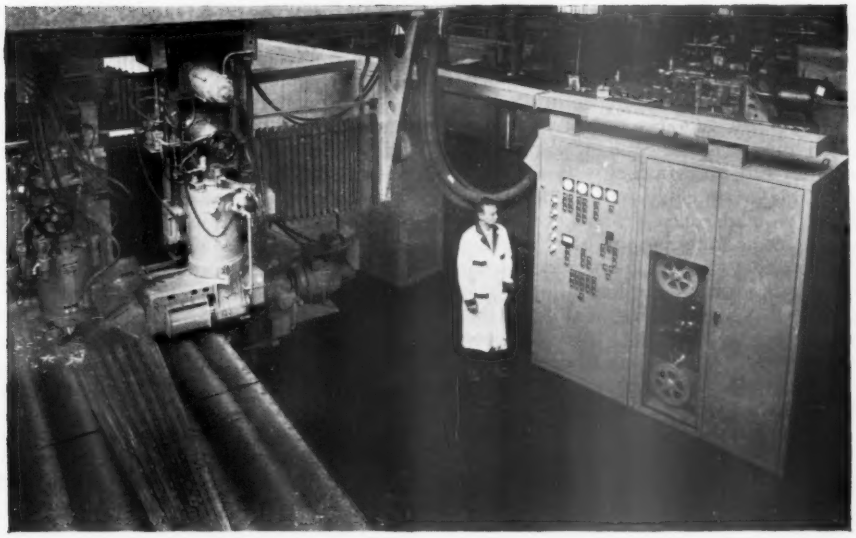
2. Precision and machining versatility of the new Giddings & Lewis Numericord System of machine tool automation are shown by the "plunge", "channel" and "pocket" milling cuts performed by this spar and skin milling machine under complete control of a numerically-prepared magnetic programme tape. In addition to these cuts, the system's accuracy is demonstrated by the 4-inch radius Archimedean spiral seen in the right foreground of the aluminium workpiece. Behind this is shown the magnetic tape playback unit which controls table and both heads in feed, traverse, rise and fall.

The system is capable of simultaneously controlling as many as 5 *machine axes, in* 3 *dimensions and up to* 22 *auxiliary machine functions.* Even audio commands to the machine attendant can be included on the magnetic tape to alert him to tool change and machine inspection "stops" planned into the magnetic tape's machining programme.

(Illustrated below)

1. Previously calculated numerical data from engineering drawings of the workpiece, tooling studies and machine feed rates — prepared by planning department technicians to cover an entire machining programme — are fed into the Paper Tape Preparation Unit of this new Giddings & Lewis Numericord System of Machine Tool Automation by an operator. Using the unit's 16-key electrical control keyboard, she transcribes such data in ordinary decimal digital form. The electric typewriter prepares a visual checking copy of all data. Electronic tube - and - relay circuits of the unit verify accuracy of all data, indicating omission of "plus" and "minus" signs in distance commands, locating instances where established feed or distance values have been exceeded, checking wrong number of digits and improper least significant digit in any command. Supervisory circuits in the unit examine all data used in tape preparation, perforating additional holes for logical control of the system's electronic computing director. This director, with its power supply and magnetic recording units, is seen in the background.





(*Illustrated above*)

3. Claimed to be the world's finest machine tool to be automated by magnetic tape — prepared solely from numerical data off part drawing, tooling studies and machine feed rates—is this Giddings & Lewis Spar and Skin Milling machine controlled by the company's Numericord system. Shown on the machine's table is an integrally ribbed skin for the new North American F-100d Super Sabre's horizontal elevator. In such airframe configuration work this new system of automation is estimated greatly to reduce machining time as compared to operator-controlled methods on the same type of machine. Seen at the right, are the system's magnetic tape playback and machine control units, which operate all machine axes through servos controlled by precision synchros in close-loop, feed-back circuits to the tape reading heads. Discriminators constantly compare synchro voltage with tape signals to position machine axes accurately.

Mr. R. E. Mills (*Assistant Designer, Bristol Aircraft Ltd.*) mentioned that there were present two Past Presidents of the Royal Aeronautical Society and two Past Presidents of the Institution of Production Engineers. He was very pleased that this was so and hoped sincerely that the wide gulf between designers and production engineers was being narrowed.

Reference was made in the Paper to the question of detail design, and here something might be done to narrow the gulf. At present, in the design of airframes in particular, and also to a very large extent on the mechanical side, detail design was given to junior men with very little guidance from those above them. As Sir Roy had said, people in this country were inherently lazy. The consequence was that the poor junior draughtsman knocked out a detail which he hoped would get past all the various systems through which it had to go nowadays, and then, after a couple of months or so, the planning engineer came to him almost in tears and said; "Fancy asking us to make something to half a thou! It is terrible!" The detail draughtsman, not knowing anything about how things were made — perhaps even less than the planning engineer — said "You can have ten thou." That might sound fantastic, but it was true. It was about time that they had in the Institution of Production Engineers people who could take a realistic view about design for production, and in the Royal Aeronautical Society people who would take a realistic view about production from design. If something could be done there it would help a great deal.

His next point was of a much more general nature. He thought he was right in saying that in the aircraft industry, in spite of what was done by Government departments, policy was largely controlled by chief designers and chief engineers. Their views, which were based purely on the money return for the work which they did, went a long way with the Ministry. If chief engineers could be kept to engineering and not policy-making it would be a great help.

On the question of automation, at the Margate Conference last year there had been provided what was probably the most instructive information which had ever been given in a short period of time on this subject. One point in which Mr. Mills had been greatly interested was electronically-controlled machine tools. Frankly, he could not see the use of them. Nowadays, when it was a question of one-offs, a skilled man was required to operate the machine tool. If that were done away with they would have the same machine tool, but it was going to be much more expensive, because electronic mechanisms would be required to feed in programmes and the like. It would need a mathematician to prepare the programmes, so that the only result would be to shift the skill from one person to another, and the machine tool would cost about ten times as much. That was fine for the machine tool trade, but no good for the builder of aeroplanes!

Mr. W. E. W. Petter (*Managing Director, Folland Aircraft Ltd.*) congratulated his old friend, Sir Roy Fedden, on what he described as a very wise Paper, packed with experience and good sense. He thought that Sir Roy was right in drawing attention to the critical difficulty which had to be faced due to the shortage of engineers. Sir Roy's picture of overworked engineers on both design and production was absolutely correct. The programmes of work which the industry undertook and the tempo of that work had to be adjusted until such time as this deficiency had been made good. Mr. Petter believed that the proportion of those doing good work in the aircraft industry was much greater than the 25 per cent. mentioned by Sir Roy, though that might not be so in the country as a whole.

This shortage of engineers of the right type made itself felt in the Ministries which framed policy as well as in the firms. He felt sure that Dr. James would obtain the lead for which he had asked at the luncheon, when he inquired how the universities could help. Mr. Petter felt that the trend today might be very much towards the scientist. In the old days very many good engineers came from Farnborough and from apprenticeship schemes in the firms, but today the tendency was to channel everyone through aerodynamics or other scientific work. He was glad that the University of Southampton kept a very definite place for engineering training and training in design.

The rationalisation which Sir Roy mentioned might be necessary in some degree, but was not going to be a full answer unless it was possible to solve the engineering problem and the problem of getting a larger number of technical people to work together as a team. With large numbers it was increasingly difficult.

Sir Roy had administered shock treatment to the aircraft industry, but might not some change in the whole atmosphere of the country be necessary before the desired improvement in the patient could be brought about? It was not possible to produce a good design in a firm in which there was no co-operation between departments; was it possible to have a healthy aircraft industry in a country where short hours and crippling taxation were the order of the day? It seemed very doubtful. The capital investment which could be made in industry in this country was pitifully small and profits were largely diverted into the Exchequer, so that the position in these respects compared very unfavourably with that in America. In this country a firm thought it was doing well if it acquired two or three large machine tools in a year, but small firms ought to be buying at least a dozen, and large firms many more. When they saw executive engineers having to take their children to school in a second-hand car and their wives having to work like navvies, whereas in Russia they would have half-a-dozen servants to help them, and in America, though they would have no servants, they would have good cars, and lots of gadgets, the question arose of how such people, taxed to the limit, could give of their best. Perhaps, however, they were coming to the end of their Cromwellian period and an awakening was not far off. He hoped that that was true, because until it came he did not think that

it would be possible to have a really healthy aircraft industry.

Viscount Caldecote (*Director, The English Electric Co. Ltd.*) underlined the point made by Sir Roy Fedden and by Mr. Petter of the importance of men in the problem under consideration. It seemed to him, he said, that all their problems could be traced to the lack of suitably trained and qualified engineers. If there were not enough wind tunnels and computers and presses or whatever it might be to do the job it was because people had not demanded them, and they had not demanded them because there had not been sufficient predominance of the well-trained engineer. It all came back in the end to men.

What was really necessary was to alter the balance of men with good brains going into engineering and those taking classics, history and economics, so as to get more men with good brains into engineering. They could all make a contribution to that end by emphasising at every possible opportunity to headmasters and others the vital importance of engineering to this country. It was no good having all the finer things of life if the country could not support itself. They could all make a contribution in that direction. He wished that a better example was set by the Government, who, though they had moved a long way, often appeared to give preference and better opportunities to those who were not technically trained rather than to the well-qualified engineer. If, however, there was more propaganda to impress on the young the wonderful opportunities in and the tremendous satisfaction offered by the engineering profession, it would do more than anything else to help to solve the problem.

Professor E. J. Richards (*Professor of Aeronautical Engineering, University of Southampton*), while agreeing with Sir Roy Fedden completely in the shock treatment which he had proposed, felt that it might be worth while to add a few figures to the statement of the problem, because the amount that could be done by improving efficiency was so small compared to that which really must be done. Mr. Woodward-Nutt, in his paper to the Conference in 1955, gave figures which indicated that America spent 22 times the amount of money on aircraft that was spent by this country, which, even making allowance for the difference in salaries, meant that the amount of man-power involved was at least seven times that in this country. Even if the Ministry of Supply and the industry were made highly efficient, he felt that there was a great deal more that had to be done. It was obvious that it would not be possible to improve the output seven times for the same man-power, so that either the taxes must go up and more people be employed, or it was necessary to think about methods by which we would not require design and development teams for every aircraft that we needed in service.

First of all, this raised the question of cutting down the number of types. It was easy to say that duplication must be avoided and that a number of different prototypes must not be produced for the same specification, but he did not think that the Americans cut down their number of types very drastically. They had a good deal of wastage, and indeed it was the only way of ensuring that some of the types turned up trumps. In the case of the one aeroplane which had been mentioned in the civil field as a great success, it had been touch and go at one stage whether work on it would go on. It depended very largely on things which could not be predicted.

He suggested, therefore, that, over and above efficiency in every aspect, which he agreed was essential, they should do all they could to cut down the amount of work which they were trying to do. Since the War, the industry had gone in for guided weapons, and almost every firm had set up a large empire on guided weapons, while still keeping the same types of normal aircraft; much effort had also been spent on helicopters. Did Sir Roy feel that this was right? Professor Richards suggested that they should get together with America in order that the design and development effort on some types of military aircraft should be shared between the two countries. This would ease the burden of development of all types, the real bottleneck, and allow some of the present excessive design effort to be guided more towards the successful development of the fewer types of aircraft so obtained. It was crazy, really, that the British and the Americans should be making aeroplanes independently. He would suggest, for instance, and purely as a provocative proposal, that fighters should no longer be designed and developed in this country but rather that American fighters be bought. He knew that this suggestion needed great courage of execution but unless Britain did something of that kind, cutting its coat according to its cloth and ensuring that it had less work to do, he was sure that the other suggestions made by Sir Roy would only be nibbling at the problem.

Mr. F. C. Bartlett (*Production Director, Heathway Engineering Co. Ltd.*) said he represented that much-maligned class, the contract toolmaker. Since the Author of the Paper had been so outspoken, Mr. Bartlett would like to say categorically that the aircraft industry today was wasting Britain's toolmaking capacity. His experience went back to the days when he had been concerned with Sir Roy's own machine, the "Blenheim" and later Sir Walter Puckey and he had discussed the production of bomb carriers for the "Halifax" and so on, up to the latest machines being produced. He said that to show his qualifications for saying what he was going to say.

Mr. Mills referred to the bad drafting of detail parts. Many toolmaking firms in this country would say that lots of parts for which tools had to be provided were absurd in their shape and also suffered on occasion in the number of degrees contained in a circle, sometimes 360 degrees, others more or less. The number of thousandths in an inch depended upon the experience of those who were dealing with the drafting of the part. His suggestion would be that the aircraft industry should have good detail draughtsmen originally, preferably with shop experience; after that, good planning engineers with the

same qualification, because the draughtsmen referred to by Mr. Mills were not always apparently concerned as to whether a part could be made or not. Thus a bad designer would produce an extremely difficult part, for example; this would be passed to the planning engineer who, if he lacked the necessary experience, would blithely put down a series of operations which according to his planning remarks would ultimately result in this absurd part being produced. These planning sheets were then handed over to, say, an inexperienced tool-draughtsman, who would endeavour to draw up a tool which would produce the part in question.

After all these efforts, the resultant tool design was handed to the poor toolmaker, who did his best to produce tools for a part which, although absurd in shape, could probably have been designed much more simply with the ultimate toolmaking difficulties in mind.

The accusation which Mr. Bartlett brought against the aircraft industry was that they were not consistent in the way in which their tools should be made. If some central toolmaking body could be formed (on the lines suggested by the late Mr. G. C. Trowbridge during the late War) for producing special tools for the aircraft industry, not so many tools would have to be made, but efficient tools would be provided.

Some firms used lofts, which in Mr. Bartlett's view were very good, but again all firms did not use them; some still used the old-fashioned method of having drawings with ordinates and when two men laid them out side by side they would not agree. How many times were references gauges made which would not even go into the main structure, or alternatively main structure jigs made which would not accept the appropriate reference, simply because somebody lacked the necessary knowledge and/or experience for designing them correctly in the first instance?

He suggested, therefore, that all the firms in this country should combine to get out a unified form of tooling, so far as they were able to do so, and should adopt one particular method of lofting, if that was to be the decision, so that the tool-makers could use their skill for the aircraft industry to the best of their ability and so that none of their time would be wasted.

Mr. R. L. Lickley (*Chief Engineer, The Fairey Aviation Co. Ltd.*) supported what Mr. Petter had said about the need for manpower, but felt the Paper put forward far too gloomy a view of the present state of the aircraft industry. He did not believe that the state of the industry had, since the War, been as bad as was suggested, and he was certain that far more than 25 per cent. of the people that he knew in all sections of the industry worked hard at all hours of the day and night.

In trying to get people to enter the aircraft industry they were competing against many other engineering industries, and in particular the atomic energy people, who were taking a great many good men. They must be cautious about a continual stream of criticism of the aircraft industry. The present Paper, as he read it, suggested that the whole of the design and production organisations needed reshuffling, that fewer jobs should be done because it was not possible to do all the jobs properly, and that if they did as the Americans did they would be better off. He thought that that was quite wrong; and, what was more important, if he were a youngster thinking of going into engineering and read the Paper he would not go into the aircraft industry but into some other which was praised as being wonderful. If they were to get people into the aircraft industry they must do more to publicise its triumphs, of which there had been a great many since the War, rather than point out supposed shortcomings.

Mr. W. J. Morgan (*General Manager, Machine Tool Trades Association*) said that it might well be supposed that there were many things in the Paper which he could discuss, but he would content himself with dealing with one or two. He had been glad to hear Sir Roy say that he had been to the two Machine Tool Exhibitions held since the War, and offered to Sir Roy and to everyone present an invitation to see the continued progress of the machine tool industry at the exhibition to be held commencing 22nd June. It would be found that the machine tool trades had not been so backward in some respects as might be supposed from what was said in the Paper.

The machine tool industry used designers and draughtsmen and engineers and was also desperately short of them. If there was any designer in the world who was overworked today it was the poor machine tool engineer, who was trying to keep up with the demands of every other engineering industry, each one of which thought that the machine tool industry should drop everything else in order to satisfy its particular requirements.

He felt sure that Sir Roy did not intend them to take seriously the suggestion that the machine tool engineer should set himself up as an electronic designer. The machine tool industry was dealing with the problem in another way, which he was sure was the right one and which was on the lines of that adopted in America. Through the courtesy and kindness of the Director of Guided Weapons and Electronics, they were enjoying the closest possible co-operation from those experts who had done so much good work in that field and who were anxious that the inventions and ideas evolved for purely defence purposes should be placed, within the limits allowed by considerations of security, at the disposal of machine tool engineers. That was being done.

Sir Roy Fedden, in reply, said that many of the views expressed in the discussion had been a confirmation of, elaboration of, or a new slant on, things which he had tried to say in the Paper. If Mr. Hollis would refer to the full text of the Paper, he would see that it emphasised the importance of drawing up specifications correctly initially, and the difficulties caused by issuing a specification and then changing the type afterwards. It all came back to the necessity for collaboration and understanding between the customer and the supplier.

Mr. Hollis had given useful facts and figures about

stretch presses. Sir Roy was aware that in the U.S.A. the engineering section of the Pentagon had been long-sighted in ordering a range of special machine tools, and there were people there with a deep knowledge of their subject. He had called attention to the five-year committee because he thought it was lamentable that that argument should have gone on without any action. This country could not spend money rashly, but the problem was so tremendous and so important that we should have the courage to embark upon one press. He would not take up further time by discussing that, but he well remembered all the talk in the Press about cylinder head milling and the waste of money on forged heads which went on before the War, and was eventually proved to be entirely wrong.

He agreed that the final type of machine tool to which he referred would have to be properly designed. People with the necessary machine tool experience should get all the background and experience which was available from electronic specialist firms. He was familiar with the work which had already been done by Scott and Lawrence in this respect in collaboration with E.M.I. and the machines which were being produced as a result of this collaboration.

Many of the audience would be familiar with the type of machine to which Mr. Chambers referred. We should all like to have as much money as possible for such new projects, but he did not think that our troubles were due to lack of money ; he was firmly of the opinion that they had been caused mainly by indecision, and in many cases to backing the wrong horse.

Mr. Mills's point about detail designers was very important, and was closely allied to Mr. Bartlett's comment that a good deal of the detail design of the jig and tool drawings was done without proper supervision and without suitable thought about production. Something could be done there at once which would do a great deal to help the position. The S.B.A.C. and the Royal Aeronautical Society could collaborate on a special set of courses. They might not have the staff themselves to undertake that work, but there were many places where excellent collaboration would be available to teach detail draughtsmen and the supervision of detail drafting, which was even more important than the draughtsmen themselves.

It would not take too long to deal with Mr. Mills's comment on the electronic control of machines, but he felt, and he believed that many others present would feel, that our future depended to some extent on single-purpose tools, electronically controlled, and that they need not be extremely expensive.

Mr. Petter emphasised the need for better engineers. Sir Roy had tried to bring that out in the Paper and had said what he felt about it on many previous occasions. He believed that the need for really sound engineers was more important than the need for specialists. He agreed that it would be difficult to get the sort of keenness and imagination required in the aircraft industry unless the whole country was willing to wake up and take life more seriously and get more fun out of it by working harder ; but was it not better that the aircraft industry should set the example ? Somebody had to make a start.

From what he had said, Sir Roy gathered that Mr. Lickley thought he had run the aircraft industry down, but in fact he had had a wonderful life in it and he had always said it provided one of the finest careers in the world. He had said several times in the present Paper what a worthwhile and enthralling profession it could be. The fact that it had not tackled the job in a far-seeing way during the last few years did not make it any the less satisfying as a profession.

Both Mr. Petter and Mr. Lickley felt that his figure of 25% for those who worked hard was too low. Sir Roy had raised the matter with several experienced friends before deciding upon any figure. He suggested that Mr. Petter and Mr. Lickley were dealing day-to-day, for the most part, with managers, designers and their own experienced people, and, taking an overall figure for the whole plant they were probably not in close personal contact with more than 10 to 15% of their staff. In giving a figure of 25%, which he still believed to be correct, Sir Roy had had in mind the whole labour force of the industry. He would sincerely like to believe that Mr. Lickley was right and that he himself was wrong, but he was sure this was not the case. In putting forward these statements, his one object was to make a contribution to the aircraft industry, of which he was tremendously proud and in which he had spent his whole life.

Broadly speaking, he had given the facts as he knew them in regard to the numbers of fighters and bombers. This country had never been in that position before in the whole of the period during which he had had anything to do with the aircraft industry ; never before at a critical time had we been so short of an adequate Air Force and of the right type of machines for the Services. That was a very sobering thought which must be recognised. He might be wrong about why it had happened, but he did not believe that he was ; he believed it was because our policy decisions and leadership had not been correct.

Professor Richards had made a number of suggestions. Sir Roy was not keen about cutting down the number of prototypes ; he had been talking more about the number of types of machine which went into production. He did not want to refer to specific machines and had kept away from doing so in his Paper, but there were plenty of examples which could be given over the last seven years. There had been very few occasions when there had been too many prototypes ; the trouble had been that when a prototype had not been satisfactory it had been pursued for too long, and a decision had not been made about production early enough, or the specification had been excessively altered.

Professor Richards' suggestion about collaboration with America was one which Sir Roy had already discussed elsewhere. There were certain post-war Service aircraft — carrier types, for example — of which this country had not yet touched the fringe and on which American help ought to be sought. But there was the difficult question that arose from competition in the civil aircraft market. It was difficult to expect hard-headed American constructors to

collaborate and give British firms all the help which was wanted, for example, on Naval machines, when they were competing with them all the time in world markets for civil aircraft.

He thought that Mr. Bartlett's points were good ones. A great deal could be done to bring sanity, rationalisation and sense into tooling design, and aircraft detail design generally. Training courses within industry would help here considerably. He had gone into them in some detail in the Paper and had tried to show that we had not been very practical in tackling the job of upgrading and training people. We had talked about it but had not done much about it so far.

In spite of what Mr. Lickley had said, Sir Roy insisted that he was not crazy about American methods and he did not say that the only answer was slavishly to copy them ; but when something which had very likely emanated from this country had been "productionised" and rationalised in America, he deplored the practice of running it down for two or three years before finally adopting it here. He could give many examples of that kind which had occurred in the last few years, such as equipment for surface finishing, crack testing, strain gauging and now computing. These had all been developed into common-sense practical jobs by the Americans. Three of them had been designed, made and developed in this country, but we had not had the imagination to rationalise them or to put them into a form in which they could be employed cheaply in production.

He hoped to visit the Machine Tool Exhibition next June. He had been to several since the war and had many friends in the machine tool industry ; but when going round works recently, he had been distressed to see so many foreign machine tools which had been introduced into British aircraft plants during the last few years. These types of special purpose machines were going to become more and more important and would play a greater part in the production of the new family of aircraft and engines. He hoped that at the next Machine Tool Exhibition he would find that some of the British firms who had the ability to design such machines would come forward with samples of suitable types for modern aircraft and aero engines.

The Chairman, in closing the session, said that the meeting reminded him of an aircraft programme. It started late, they had discussed everything under the sun, and they delivered late. He did not intend to sum up, because he felt that enough had been said. Generally speaking, Sir Roy had cast his flail over a very wide area, perhaps too wide to suit Mr. Lickley, who had felt that Sir Roy was being a little unfair to the aircraft industry generally. Many of those present would have chastised at some time or other some other section of the industry. That would always happen and probably made for a healthy industry. No doubt they would go on criticising each other, and perhaps other sections of industry as well.

Dealing with Mr. Petter's point, and to some extent in support of Mr. Lickley, it might be said that some of the problems of the aircraft industry were very similar to the problems of other industries today in this country. There were national reasons for that, and Mr. Petter's wise words, which were obviously appreciated by everyone, struck home, because some of the problems were not being discussed in a parochial sense and were part of bigger problems. The aircraft industry would increase its stature not in a closed circuit, but in relation to other industries which would become of increasing importance for the aircraft industry, which could not live by internal activities alone.

Sir Roy had covered a very wide area with criticism, and had perhaps, as Mr. Lickley said, criticised unduly some sections of the aircraft industry and perhaps some of the achievements of the industry. It was necessary to bear in mind, however, Sir Roy's unrivalled position for finding out what was wrong and suggesting what might be better. They would all, including Mr. Lickley, be grateful to him for his presence that afternoon and for giving them a very great deal of information which each one of them in his particular area, and many of them in many areas, would look at to see whether there was something which they could do better. That was the purpose of the Lord Sempill Paper, and it had been admirably achieved. Lord Sempill would certainly agree that the Paper had been a masterly beginning to the Sempill series.

The Conference then adjourned for tea.

TIME CAN BE SAVED—

in the aircraft industry

by H. G. GREGORY, M.I.Prod.E. and A. VINES, A.F.R.Ae.S., A.M.I.Prod.E.

Mr. Gregory, who is Vice-Chairman of the Institution's Council, served an indentured apprenticeship with C. A. Vandervell & Company at the close of the First World War, and studied mechanical engineering at the Regent Street Polytechnic. He has held senior executive positions in industry and before taking over in 1943 the management of the Northern Factories of The Fairey Aviation Company, Ltd., was Director and General Manager of Burtonwood Repair Depot.

Mr. Vines, after completing a general engineering apprenticeship, joined the Drawing Office at Saunders-Roe and later the Drawing Office of Fairey Aviation Company, Hayes. In 1936 he was appointed Assistant Works Manager at Stockport and later Works Manager at Errwood Park Shadow Factory. After the War, he returned to Hayes as Production Development Engineer and later Deputy Chief Engineer. In 1951, he was appointed Production Manager to co-ordinate production work in all factories in the Fairey Group.

(Parts I, II and III of the Paper were presented by Mr. Vines, Parts IV, V and VI by Mr. Gregory.)

PART I — BACKGROUND

TIME, in aircraft production, will always be a vital factor and if military and commercial aircraft continue to develop at the present rate it is essential that aircraft production techniques are developed to keep pace and the effort to save time will have to be maintained at a high level. However, those who design and build aircraft are only human, so there must be many ways of saving time by improving our organisation and methods.

Aircraft firms, from the very beginning, have had to deal with a product that is constantly changing but must be manufactured to the highest standards. If you examine the history of the industry from 1914, you will find it has passed from full production to no production at short intervals as the international situation changed. Fig. 1 clearly shows this trend and the amazing fluctuations. No figures were published after 1945 so that the curve is imaginary.

The first real test of the industry came in the 1914 War, when it was admitted that aircraft were a vital factor in attack and defence, although little, if any, encouragement had been given to the pioneers to develop military aircraft. By 1917, 26,000 aircraft were built in one year. After 1918 production was reduced to a trickle and the majority of the labour dispersed.

A period of comparative quiet continued until the crisis of 1935, which found the country with very few aircraft and very limited production facilities.

The industry was faced with expansion problems, made more difficult by dispersal, lack of trained labour, material and machine tools. However, by 1943 a production rate of 26,000 aircraft per annum was again reached, of machines in no way comparable to the 1914 vintage.

It is interesting to note here that a Productivity Team from the U.S.A. visited this country to see how it was possible, in conditions of blackout and bombing, to achieve an output per man which, in a number of cases, was higher than in the American industry at that time.

This effort continued until about 1945, when the industry was again shut down and the majority of the 2,000,000 labour force dispersed.

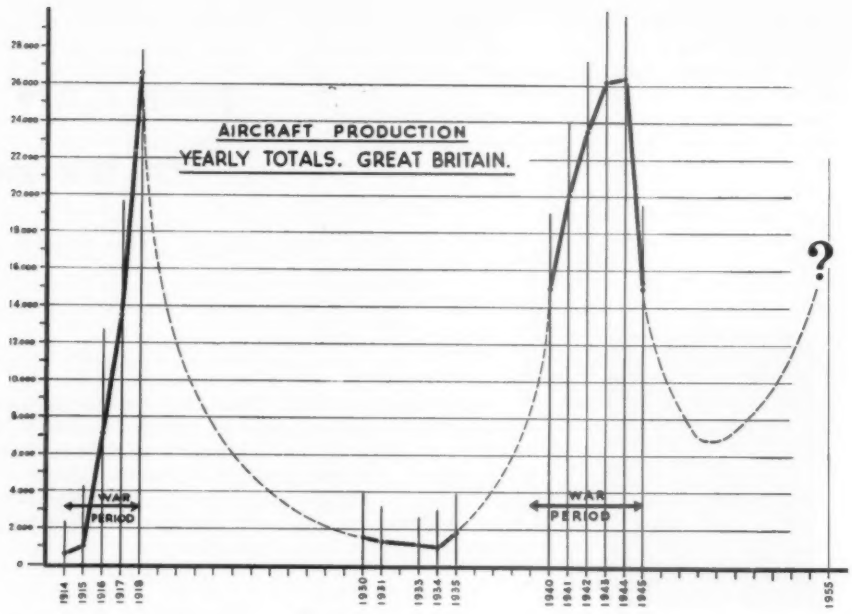


Fig. 1. Graph indicating the fluctuations in the aircraft industry from 1914 to the present day.

It was thought at that time that building commercial transport aircraft in production quantities might be possible, but the lead the Americans had obtained and the War surplus aircraft available made this impossible.

Since this period, some notable progress has been made, but no real production of transport aircraft has been started and the orders to date are for comparatively small numbers. About 1948 another expansion programme started, this time on a new breed of aircraft which were only in their development stages. These aircraft had to be developed and built at one and the same time and the industry has been criticised for not solving all these problems without running into difficulty.

There must be many people present who have lived through the effort and disappointment of these cycles who realise what the industry can do, given the opportunity. Let us hope that it will not be another War that makes the country realise that goods as well as passengers can be transported by air. The Berlin Airlift was a pointer in this direction which we must not ignore.

To illustrate the development of the industry in more detail, it is interesting to study the history of the Fairey Aviation Company, of which I have more knowledge, but which is typical of most.

The curve of output shown in Fig. 2 shows a similar trend to the period from 1935 - 1945, when dispersal units and shadow factories were in full production, and indicates the magnitude of the effort.

It is very interesting to note that in 1935 we had, in an advanced state of manufacture, a four-engined pressurised airliner which even today has a modern appearance. This was cancelled due to the War emergency and the privilege of building transport

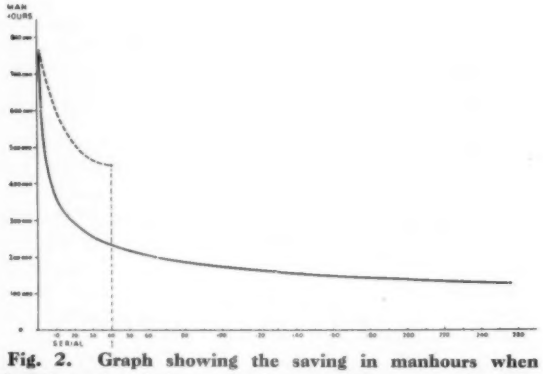


Fig. 2. Graph showing the saving in manhours when building aircraft in production as against small batches.

Fig. 3. Gannet, A.S. Mk.I.

Fig. 4. Delta F.D.1.

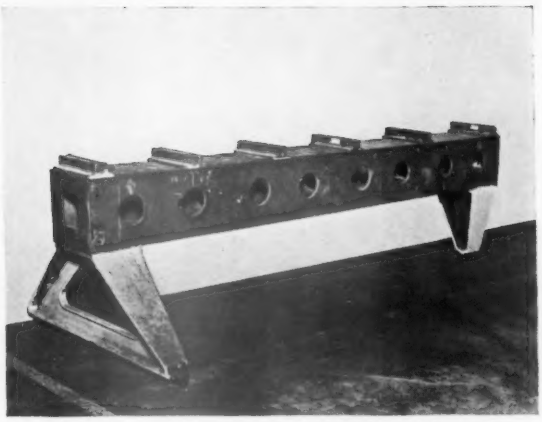


Fig. 6. Typical standard jig base used for the majority of envelope type jigs.

aircraft was handed to our American friends, who have made full use of their experience.

Fig. 2, which is based on well-known statistics, illustrates the saving of time and money from which the country will benefit if reasonable quantities of the same type of aircraft are built.

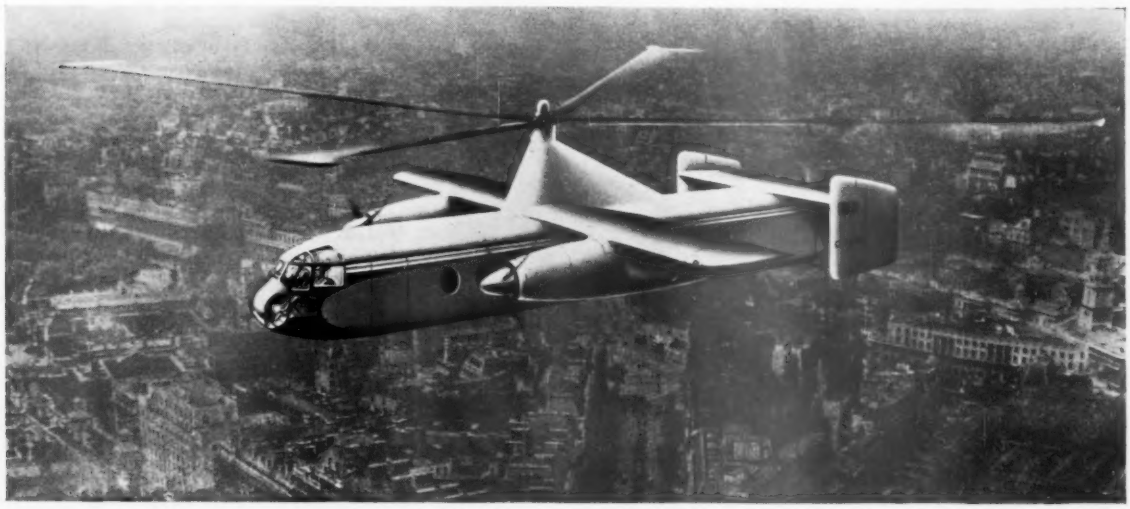
Savings are also considerable in other directions, as when building small quantities nearly all the work is done by skilled labour which is in short supply, but with larger quantities it is possible to tool assemblies and details so that a lower grade of labour can be employed, thus helping the national effort. One could enlarge on this subject for hours, but to everyone it must be obvious that the advantages in time and cost are enormous.

Our lifeline in the past has been the Merchant Navy. It is now clear to a growing number of people that part, at least, of our lifeline, is now air transport.

It can be proved, even today, that it is cheaper, safer, more reliable and infinitely quicker to transport certain classes of goods by air, and the following two examples of which we have had experience indicate that there is ample opportunity, once this has been fully exploited and suitable aircraft are available.

We are shipping consignments of Fairey Hydro Boosters to Canada by air in three days instead of twenty-three days taken by sea, and the air transport is *cheaper*. This is due to the fact that only light packing is required for shipment by air, which saves labour and material on heavy packing cases, which also means that the wood for these cases does not have to be imported.

Fig. 5. Rotodyne.



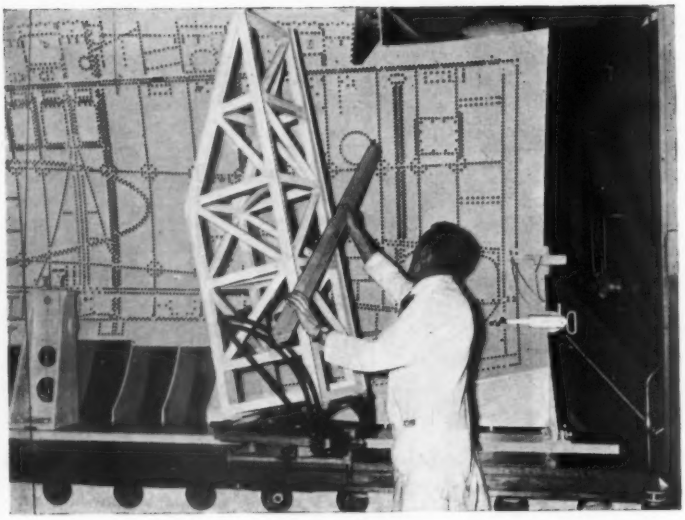


Fig. 7. Use of the Fairey three-dimensional lofting equipment for marking out jig skins.

We have a similar case of shipping aircraft parts to Belgium. They are packed at Blackbushe and flown straight to the factory in which they are used, in a few hours. Shipment by sea would mean heavy packing cases and weeks of delay. We find that we can also send goods from LONDON to MANCHESTER cheaper by air than by passenger train in a quarter of the time.

It is evident that the day is not far off when certain classes of goods will all be shipped by air, so that a Transport Fleet will be as vital to our export trade as it already is to our national safety. Vast sums of money could be saved in the long run by a bold policy to equip this country with a Transport Fleet, both commercial and military. Many people have already said this. What is needed now is action, supported by the growing wave of public opinion.

PART II — ORGANISATION

I have tried very briefly to show that the history of the industry has been intimately connected with the national safety and what is needed today is a steady production of commercial aircraft, so that production labour is maintained and the industry is strong to deal with emergencies.

It was during the expansion which started in 1935, and the production and tooling effort of the War period, that made us realise that a method was needed whereby aircraft could be built more accurately, so that we could, from the beginning of a production contract, achieve good interchangeability, not only of components, but of detail parts and sub-assemblies.

This is essential to good production and a tremendous asset to the operator of the aircraft.

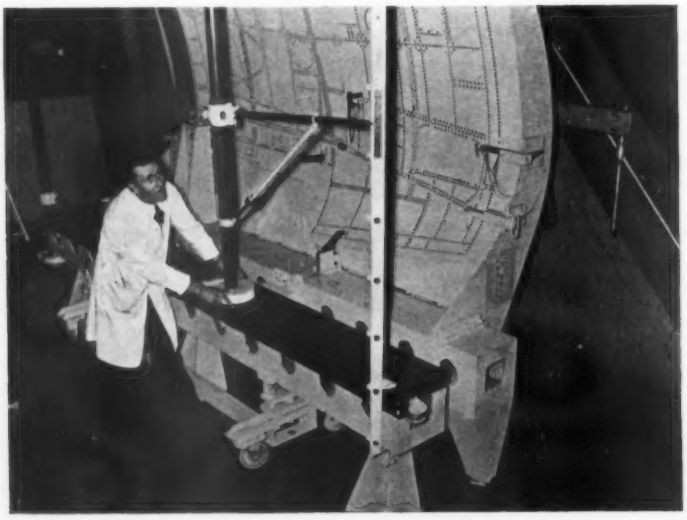


Fig. 8. Use of the Fairey three-dimensional lofting equipment for marking out jig skins.

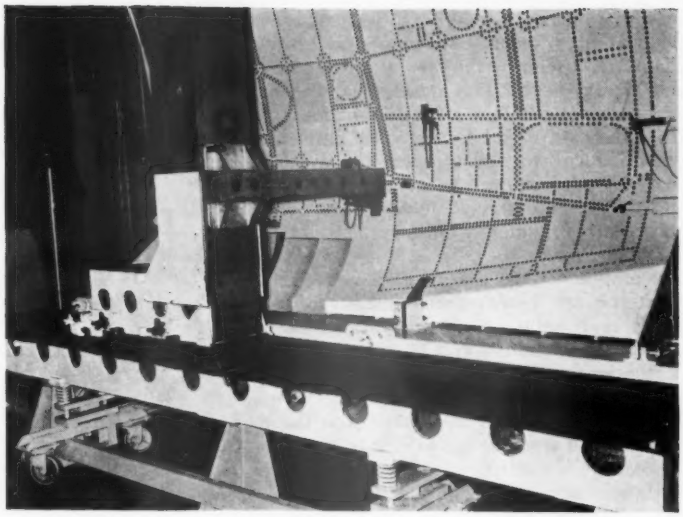


Fig. 9. Jig building and three-dimensional lofting equipment for setting jig pick-ups.

During this period we had a wide variety of experience and produced 10 different aircraft, in quantity, in 10 years.

In 1944 I was also able to study the methods of 12 American aircraft factories in full production. At that time their organisation varied widely, but their methods were similar to ours.

It should not be forgotten that it was the orders from this country and France which started the expansion of the American aircraft industry before the U.S.A. entered the War.

There were many problems to solve during the War, but the three outstanding ones, in my opinion, were as follows :-

1. To produce aircraft with unskilled labour, good sub-assemblies were essential, but in the majority of cases these had to be developed as production progressed; and to get modifications to an existing design is always difficult, once production has started and the technical labour transferred to another type.
2. To organise Stores and Progress so that details are available in the right place at the right time; when this means the turnover of tens of thousands of parts in small batches subject to constant modification, the foundation on which this organisation rests is very important, and is a source of trouble in most factories.
3. To build a series of aircraft of the same shape so that flight tests are reduced to an absolute minimum, as the number of flight tests due to variations in control surfaces, etc., were far too many.

These problems were faced by all firms in varying degrees and I will describe briefly how we have modified our organisation in an effort to deal with them.

Since 1945 we have built seven types of aircraft, two of which have been built in quantity, so we have had the opportunity to develop our ideas.

I must make it quite clear that to achieve any success in this it is essential to have the full understanding and co-operation of the Design, Inspection and Works staff. The days have gone when one man could design an aeroplane. Today, many sections of Design, Development and Manufacturing organisation contribute to the completed job, and it is the effective use of this effort which is most important. I think time can still be saved by a well integrated organisation working to a definite plan from top to bottom with as much individual responsibility as possible, as there is no substitute for individual initiative and leadership.

In order to achieve this we have modified our systems and organisation several times and no doubt shall continue to do so, but we now have a parallel organisation in all our factories, which helps considerably the interchange and co-ordination of effort at all levels.

A brief outline of the organisation is as follows :-

The Design Office is divided by types of aircraft, each section being led by a Designer, Chief Stressman and Design Section Leaders, backed up by Development Test and Structural Test, etc. Working closely with this group is the Production Development Section which is responsible for all tool design and development.

On prototypes they work with the Experimental Shop and with Production Shops as soon as a type is released for production. By this means we have a valuable continuity in the tool development from prototype to production.

The group is sub-divided into sections, consisting of Assembly Development and Installation, who work in the Design Office, Machining Development, Plate Development, Plastic Development, and numerous other groups who are called in wherever and whenever their services are required.

Mr. Gregory will describe in more detail the activities of some of these groups.

By this means, assembly, sub-assembly, and interchangeability aspects of design and also types and designs of assembly jigs are studied from the very start of a project. This means that there is time to lay out jigs and obtain lofting information before the loft is busy on detail lofting. In most cases jigs in skeleton form for prototypes are available before the detail parts are ready for assembly.

The Planning and Ratefixing Department work closely with Production Development. They prepare all Detail Process Sheets and order the Tools. They also compile Group Requisitions on which assembly operations are based from Design information on Details, and sequence of operations on assemblies supplied by Production Development. From this information they prepare time studies, jig requirements and shop loading.

This system has the advantage that the Ratefixing Department is working to realistic up-to-date planning and has full control of all shop operations and modifications.

The Finished Part Stores and Progress, which are combined, are also in the picture from the beginning of a production type, as the Stores are organised so that each Department building a component or group of components is self-contained with Stores and Progress, Inspection, Planning, Ratefixing and Shop Supervision. These Progress Stores deal with all phases of the work on their particular Section, including Spares, Modifications, etc.

The Stores are located in the Assembly Department they serve and the Stores control has a visible record system showing the position on each group, and on a new type, also, the position of the tools.

From the above you will note that we have no separate Detail Shops, but all work, except that requiring special equipment like the Press and Machine Shop, is done in one Department on a component or group of components, including installation and testing.

We have found this far more effective from all points of view, as all concerned, from the Design Section Leader, Assembly Development Engineer, Planning and Ratefixing, Shop Supervision, Inspection, Stores and Progress form a very effective team with the maximum interest and individual responsibility. This, I think, makes the job more interesting and encourages those concerned to get things done, and the foremen get maximum help which they need when starting a new type.

PART III — METHODS

I will now return to the design and building of assembly jigs.

The industry, as we all know, must be flexible, so the flexibility and mobility of the tooling is very important. Starting a new type in production which requires large assembly jigs permanently fixed to the floor means being right first time with shop layouts, and any dispersal or expansion is a major operation.

Sometimes these jigs are stronger than the sub-assemblies mounted in them, so that the components become distorted during assembly and when completed and released, trouble is experienced with interchangeability. It is far better to make the sub-assemblies right, as no amount of clamping and pulling will correct a component which has not started right in the first place.

If sub-assemblies are accurate, very simple final assembly jigs can be designed.

The construction of these jigs has always been difficult, especially on large aircraft. A wide variety have been used in the past, and the type we have employed until recently have not been stiff structures, but fixed to the floor, so that they are difficult to move or disperse to other factories.

They were set by large references which were subject to distortion and never available for the first jigs, so these were set up and checked by standard shop equipment, quite often with the aid of wires and plumb bobs. Everything had to be designed from scratch and very few standards were used.

There were separate supports for all frames and ribs, and quite often the structure of the jig was inside the component which makes access very difficult.

The skin was assembled as the last operation, so that any variation in the structure was reflected in the shape of the component.

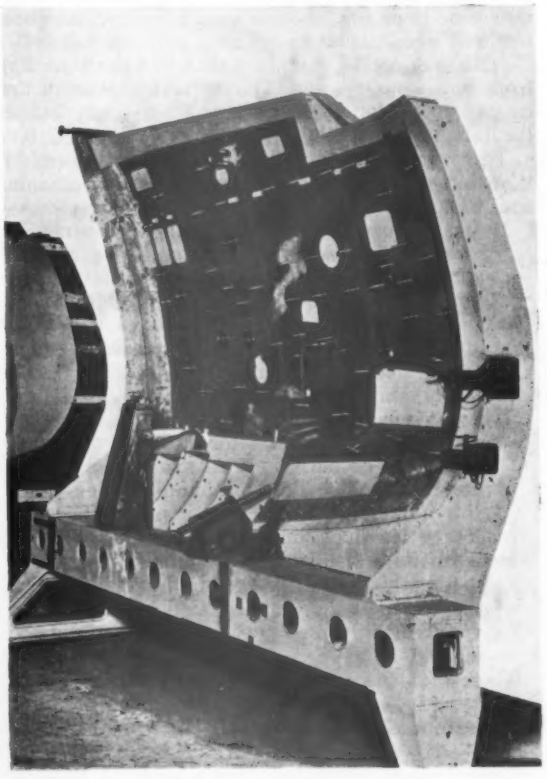


Fig. 10. Envelope jig with the skins assembled ready for assembly of the frames.

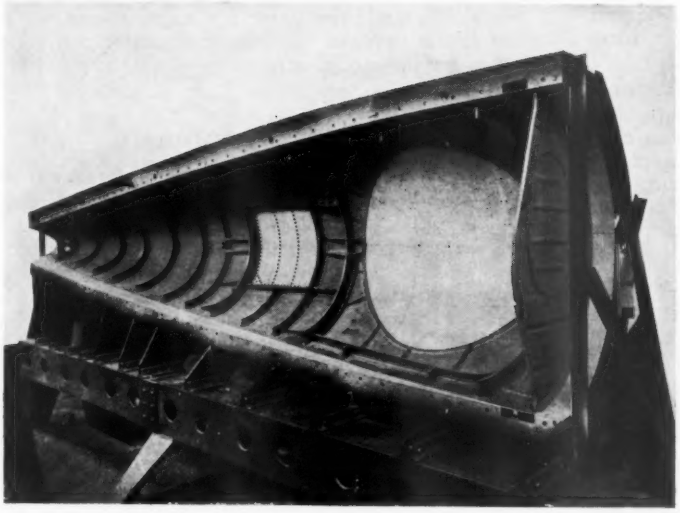


Fig. 11. Typical aircraft assembly in an envelope jig.

The increasing speed of aircraft, and the trouble we had experienced with flight testing due to variations in shape of control surfaces, etc., made it essential to improve our methods and we decided to try and develop a system of building accurate components from the start of a prototype or production aircraft. We have worked on this for a number of years and at the beginning studied dozens of designs and combinations of structures, but all locating from the outside in order to maintain a constant outside shape.

We have now developed our methods and equipment so that the building of jigs is a process assisted by a series of jig-building machines.

The latest aircraft we have built in production using this process is the Gannet, on which we have achieved a standard of mechanical and aerodynamic interchangeability better than we thought possible. We have also used these methods on the Delta F.D. 1 and the Rotodyne.

I will describe very briefly how this is done.

All jigs are built on standard bases of square sections. The square section has proved far superior to round sections as it provides datum faces and it is much easier to add lugs, clamps, location points, etc.

These bases are on three legs, so are very portable, which makes rearrangement of the shop or dispersal a simple operation. On very large jigs, more legs can be added, but levelling up is then required.

We have found that by location on the outside of a component, or on the top of a floor structure, etc., a very satisfactory assembly jig can be designed, which can make full use of standard components as the designs fall into a pattern.

The advantage of locating from the outside is that (a) you control very accurately the outside shape and (b) the outside shape is usually settled first, so work can start on jigs long before it would be possible to design a jig picking up detail components.

If the outside location is an open structure you can only clamp the skin with limited control of the shape.

If you make the outside locations a complete surface, you have complete control of the skin, especially light gauges and can, on this surface, mark out the skin of the aircraft with all cleavage lines, cut-outs, frame spacing, etc. As this information has to be obtained sooner or later, why not sort it all out while the detail parts are being made, so that when they are complete you can offer them up to this surface to check their shape, etc.?

All this information can also be checked by Inspection and is a permanent record.

To build jigs of this type, full use is made of the loft who supply former shapes to jig data sheets supplied by the Assembly Development Engineers. The formers are then made in suitable material and assembled on a standard jig base by standard fixings using the jig building equipment we have developed for the purpose.

The jig building machines can be assembled to any base by standard locations and used for adding pick-ups, modifications and also for referencing.

Imagine the advantage of being able to clamp a standard machine to any jig in production and check or add pick-ups, cut-outs, etc.!

These jig building machines have also been developed for marking out the jig surface, which we call 3-dimensional lofting. Components are dimensioned as far as possible from the three datum faces of the jig building machine.

During marking out all drawings are checked, errors corrected, and all this information is checked and passed by Inspection before work starts on the assembly of the component.

This has to be done even on prototypes, where it is usually repeated on each machine as it is built, but once the jig surface has been marked out you have a permanent record for building two or more aircraft.

Even on heavy gauge skins which have been accurately preformed and do not require support, lofting and checking their shape, etc., has many advantages.

When the jig surface is single curvature, skins can be rolled or stretched ; when double curvature, skins can be stretched or if preferred made of glass cloth resin reinforced which can be made on a plaster model, which is a convenient method of dealing with different shapes. The drop hammer tools or form tools can be made from the jig surface or the plaster model.

When the jig surface is complete it is a simple matter to clamp the skin in place. Suitable tooling holes are made for this, and the longerons, formers, etc., are clamped to the skin.

Access to drilling and rivets, etc., is made through the jig skin which is marked on the back with the length and size of fastenings, which further assists assembly.

When tools are made for sticking, welding or any other process the same methods can be applied and the jig building machine and lofting equipment used to obtain an accurate start, and the convenience of being able to use the same equipment for checking and modification during production will be appreciated.

When components are built of steel the necessity to start right is even more important, and we have found this a great advantage in the steel components we have already built, using envelope jigs as the necessity for trimming and setting components on assembly is eliminated.

If you can build sub-assemblies which are closely controlled for shape and profile and can rely on repeating this in production quantities, the need for elaborate final assembly jigs is eliminated.

All that is required is a means of levelling the sub-assemblies, picking up strong points, and providing suitable gauges to check important pick-ups or faces.

By this means you have maximum simplicity of jig and maximum accessibility, with the advantage of being able to check groups of pick-ups like wing attachments for distortion, during assembly.

It is possible to use this method on a wide variety of components if holes or tooling attachments are allowed for during design. These can be used later for repair and maintenance.

In order to follow the sequence of operations described I will show a series of slides dealing with a particular component and a number of other slides showing some typical jigs, etc., some of which show the building of the first Rotodyne which has a fuselage 60 ft. long.

These methods and the jig building and 3-dimensional lofting equipment are covered by patents. Some firms have already made use of this equipment and we are always pleased to help anyone who is interested as we now have a wide variety of experience.

I have tried to show that the aircraft industry has the background to build all the aircraft required by this country and many others, but we must build in production quantities if we are to be successful, as that is the best way to save time and get a good return for the money spent.

PART IV — PRODUCTS

In the foregoing review, we have endeavoured to show the organisation and methods which we employ, with emphasis on the assembly jigging approach.

I am now going to describe some interesting products, using well-established manufacturing techniques, and also special purpose machine tools which we have designed and produced. Regarding the latter, we are fortunate in having a well-equipped Machine Tool Division as an adjunct to our normal facilities.

I will also describe in some detail the problems of machining which have arisen from the increasing use of Integral Construction — a subject which has been discussed at previous Conferences in this University.

Rubber Bolster

There is no need to dwell upon the techniques employed in producing pressings by the use of rubber as a fluid pressure medium, but it often occurs to us in studying other Companies' methods of production, that full use is not being made of utilising the rubber either as a punch or die, as the case may be, or as a means of applying pressure to the draw face and punch. This I will briefly touch upon by describing the slide showing a typical tool. However, before doing this, a brief description of the press we use is perhaps necessary.

This is a four column upstroke press, of 4,000 tons capacity, giving ·7 to ·8 tons per sq. inch applied pressure to the rubber. The depth of rubber is 19″, which is made of 1″ layers vulcanized together.

Typical Tool

The draw tool which we have seen on this slide is for the production of a pressing in DTD.610 material,

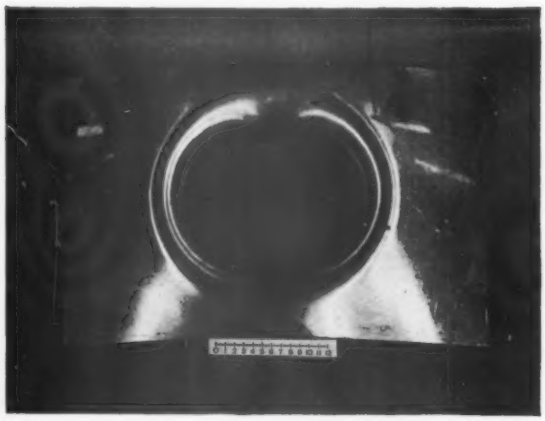


Fig. 12. Re-entrant diaphragm produced on the rubber bolster press.

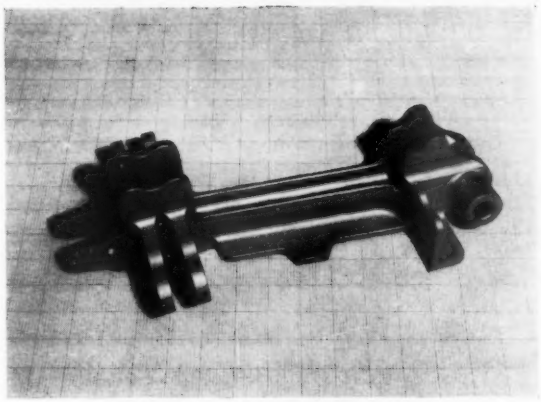


Fig. 13. Investment casting of wing attachment fitting

where pressure rings in a standard tool would be necessary. This was manufactured speedily in our Block Shop from laminated phenolic sheet, using standard woodworking machinery. Since loft templates are used, no tool drawings are required.

The blank holding pressure is applied at the same time as pressure is applied to the punch, and by this means we are able to produce a pressing involving a draw which otherwise could only be produced either on a single or double acting power press, using conventional press tools.

Typical Heavy Gauge Pressings

(a) We have illustrated a pressing (Fig. 12) which is produced from $\frac{1}{4}$" thick AW3 material.
The blank size is 4ft.×3ft. with a 19" dia. hole routed before pressing.
The pressing is formed on a concrete block, the rubber being the punch in this case.
A sample of this is exhibited.

Fig. 14. Oleo outer casing and slug after trepan boring.

(b) The next slide illustrates a pressing and the type of tool used. This part is made from $\frac{1}{2}$" thick AW3 material, 2ft. × 2ft., and is produced on the tool illustrated. To be quite honest, we have been astounded at the result that has been obtained. A sample of this is also exhibited.

(c) A further pressing, as shown, is made from $\frac{5}{8}$" thick AW3 material and from a blank of 5ft. diameter.
The blank is routed to shape, including the flanged holes, which are formed individually on a small press in the flat, and the whole is then formed to shape on the rubber bolster. This is shown to give you some idea of the size of a pressing, and is again exhibited.

Investment Castings

Tests have shown the reliability which can be obtained in high tensile steel castings and has promoted their development and use for aircraft structural parts — with tensile strengths as high as 60 to 75 tons per square inch.

The principal advantage in the use of steel castings — as you are no doubt aware — is obtained only when a considerable reduction in the number of surfaces to be machined can be effected, and for this a method such as the investment process using expendable patterns, is necessary to meet the "general limits" normally specified on aircraft fitting drawings.

First approval for the use of this process for high tensile steel aircraft structural fittings was given by the Ministry of Supply in 1950, and there has now been some five years of experience in extensive application in at least one type of aircraft. Throughout the production series of this aircraft, investment castings giving the properties called for by DTD.705 have been used for wing attachment fittings (Fig. 13), and also catapult launching hooks, and examples of these are available for inspection after the lecture.

The availability of this process in approved form has, in a number of cases, led to saving in time elapsed as well as in the labour of actual manufacture compared with alternative methods.

As aircraft production engineers are already well aware, it often happens that the last fitting in an assembly to have the design released for production is the most complicated one. Typically, a main joint is one on which the fabrication time cycle is likely to be the longest.

Circumstances which arose through a change in service requirements led to two major spar fittings, one of which is shown in Fig 13, being produced as investment castings when the programme did not permit the time which would be absorbed in the sinking of forging dies, the production of forgings, and the minimum tooling required for machining forgings. The use of improvised moulding dies for investment castings effected a further shortening of time in making sufficiently accurate castings available for the first three aircraft.

In the case of a hydraulic release unit body of a

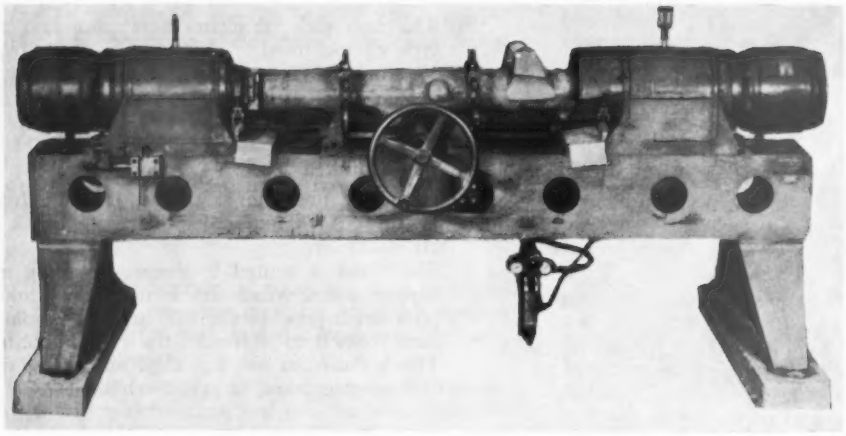


Fig. 15. Ending machine for oleo outer casing.

form which could not have been produced from a drop forging, initial production deliveries of investment castings were made within nine weeks of receipt of the drawing. This period included making moulding dies which have served for several thousand castings, and the inevitably longer period required for inspection of castings compared with forgings.

The availability of investment castings has lately proved invaluable in cases where the manufacture of urgently needed parts would be seriously delayed on account of the unusual sections of steel bar or plate which would be required.

Investment casting is a relatively flexible production method able to circumvent supply difficulties, not only where otherwise unusual sections would be required, but to provide, from a small variety of compositions of melting stock and alloying metals, castings in a range of carbon and alloy steels, covering requirements for high and medium tensile, non-corrodibility and strength at elevated temperature.

PART V — SPECIAL PURPOSE MACHINE TOOLS

The design and development of the first three machines to be described was the result of the special requirements for machining nose and main oleo outer casings (Fig. 14).

Ending Machine

The machine illustrated in Fig. 15 is used for the first operation, machining both ends simultaneously. Each end is rough drilled with a high speed spade drill $4\frac{1}{4}$" diameter to relieve the facing and chamfering operation which follows.

The 45 degree chamfer produced at each end provides a location for subsequent operations. The cutter heads are directly driven at 3,000 r.p.m. each by a 5 h.p. motor. The feed is applied by a lead screw, hand-operated to a fixed stop.

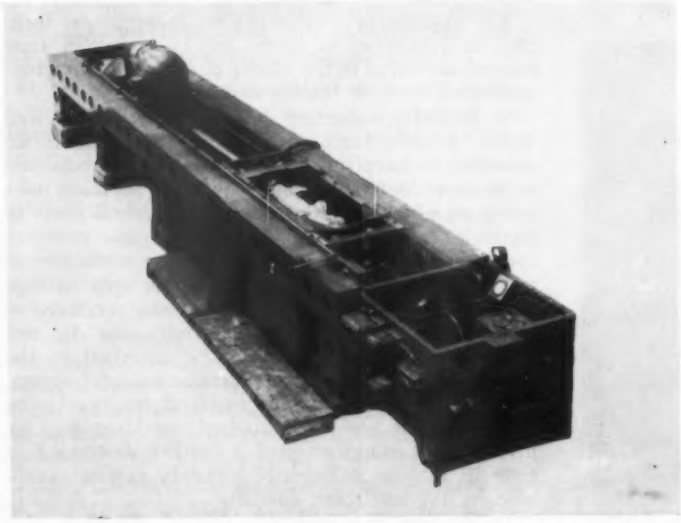


Fig. 16. Trepan boring machine for oleo outer casing.

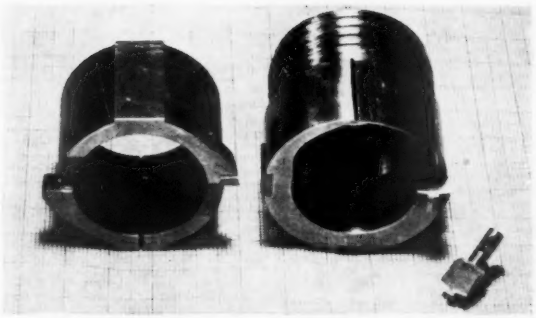


Fig. 17. Cutting head and boring head for oleo outer casing.

Trepan Boring Machine

This machine consists basically of two 24 ft. long standard jig castings, on which are mounted nitrided slides for the boring carriage, and a clamping unit of the oleo outer cylinder component (Fig. 16).

This carriage is traversed by a hydraulic jack to provide infinitely variable feeds, and has a swarf and lubricant outlet at the base. The carriage mounts a 15 h.p. 900 r.p.m. motor, which drives the trepanning tube and lay shaft through "V" belts at 700 r.p.m.

The clamping unit carries the two locating cones, which are closed by three 2-ton hydraulic jacks, and also the trepanning tube bearing, with high pressure coolant supply chamber.

The infinitely variable feed is important in determining the size and shape of the chip.

The shape of the chip breaker on the carbide tipped tool is important, particularly when cutting DTD.683, in the "as forged" condition (Fig. 17). Our experience shows that this material tends to produce large built up chips. High pressure lubricant is essential and considerable research was done to develop an effective cutting oil. The following data is of interest :-

The peripheral speed is 780ft. per min.
The bored hole is $4\frac{1}{4}$" dia. × 45" long.
Diameter of slug $2\frac{3}{4}$".
Feed 3" per minute.
Floor to floor time 25 min.

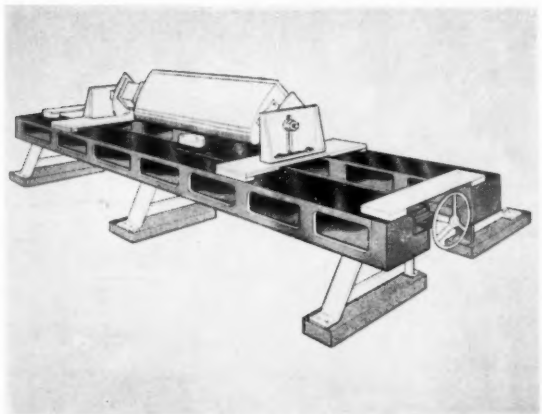


Fig. 18. Profile generating machine.

The feed quoted is by no means the maximum that can be obtained, but is controlled by the h.p. available and the tool life between grinds. Another interesting fact is that the total metal removed from the bore, including the slug, is 638 cu. in.

Boring Machine

This is similar in design to the trepan borer, and completes the intermediate and final boring operations. Again, hydraulics are used both for clamping the component and traversing the cutter bar. The boring bar is 3" dia. and 12ft. long, so that it may be constantly held in three support bearings. The cutter has opposing teeth to balance the cutting load, and adequate coolant is applied so that the chips are flushed clear. The following performance figures have been maintained :-

Speed of the Boring Bar		700 r.p.m.
Intermediate Bore	...	4·84" dia.
Finish Bore	... ...	4·925"
Floor to floor time	...	25 min. each operation.

Stretch and Forming Press

Perhaps you may remember that in 1950 an article appeared in "Aircraft Production" of the stretch forming press which we made, and the two slides shown have been supplied by courtesy of "-Aircraft Production", and show the general layout of this press, particularly in regard to the forming of leading edge skins.

In short, the operations performed by this equipment are normal stretching and brake press work but the forming of the material by pressing it into a rubber pad is the unusual feature.

Profile Generating Machine

This was developed for generating outer contours of any cuniform section (Fig 18). It can be used for machining form blocks for leading edges, trailing edge shrouds, and aileron forms.

Blocks to be machined, having master profile plates fitted at each end, are positioned to suit each face being cut and clamped to resist the cutting loads.

The machine consists of a high speed cutting head which is traversed relative to two location faces, on which rests the formers attached to the block to be shaped, thus ensuring that all faces cut are tangential to the templates at any point.

All cuts are taken in such a manner as to leave a series of flats of varying widths, which are spaced according to the degree of curvature being machined, and are subsequently dressed by a finisher disc to the required shape.

Rotomill

This is an interesting machine, designed to carry two high performance heads mounted on columns each side of a rotating table (Fig. 19). The high speed heads in this case are Mark 2, which will be described later in the Paper. These are positioned, one horizontally and the other vertically. The worktable, which can be traversed, is fitted with an infinitely variable speed drive, permitting a variety

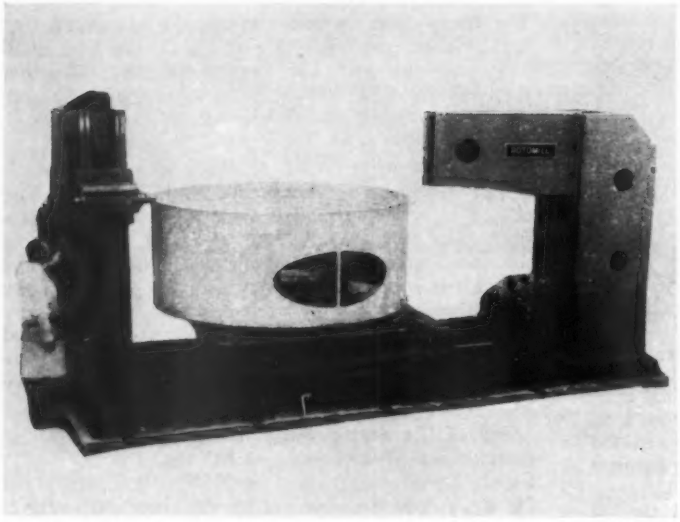


Fig. 19. Rotomill.

of diameters to be machined at optimum speeds (Fig. 20).

With high cutting speeds the finish obtained and the time saved is outstanding if compared with a standard 10ft. borer. A standard machine, admirable as this is for machining ferrous material, can in no way compete with the Rotomill for light alloy machining.

PART VI — 3-DIMENSIONAL CONTOUR MACHINING

In line with other members of the aircraft industry, over the past years we have been involved with the problems of " Integral Construction ".

Under this heading, I should like to describe the work carried out by my Company with the emphasis on milling machine problems. In order to appreciate the road along which we travelled in our investigations, it is necessary first briefly to outline our initiation in this field.

The requirements for the production " Gannet " aircraft included a large forging for the chassis rib. We joined the queue for large super priority forgings, unfortunately rather late, and soon realised that if we were to meet our programme requirements a forging was out of the question. We therefore turned our attention to the possibility of producing this rib from slab material. The limitations of material supply in this direction have already been well ventilated, and it is sufficient to say that our requirements for the rib came, with a little judicious trimming, just within the supply capacity available.

We had the material, all we had to do was to machine it to the designed shape! The first few components were produced on standard die sinking machines at tremendous cost, as will be appreciated, and it was obvious that unless other manufacturing techniques could be evolved, we would have a production bottle neck possibly worse than that of the forging.

The problem presented to our Development Engineers was how to remove large amounts of light alloy economically, and to remove it from the right places. This was no academic investigation — we had an immediate production requirement that was critical to a super priority aircraft.

It would help, I think, at this stage, to state the problems as we saw them, and then to explain our investigations and conclusions :-

1. To investigate the cutting of light alloys in order to determine the maximum efficient removal rate, and to examine cutter performance coolant systems.
2. To develop high speed milling heads to meet the performance requirements established in the investigation.

Fig. 20. Rotomill showing vertical high speed head.

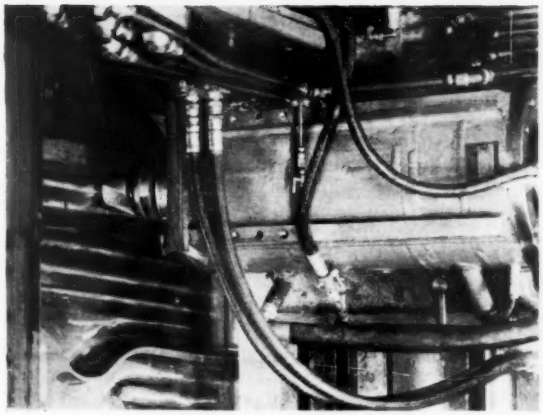


Fig. 21. High speed head Mk. 2.

3. To study the design problems associated with heavy machine tools operating at fast traverse speeds, under control of high response servo systems with a view to developing machines capable of utilising high performance milling heads to maximum advantage.

Cutting of Light Alloys

Considerable work has been carried out in investigating the problems of high speed machining of light alloys. Test equipment has been developed to study the effects of cutting speeds up to 12,000ft./min., and there is no indication that these are approaching the maximum.

Cutting tool geometry and tool materials have been studied and there appear to be no critical problems involved, excepting perhaps, the provision of spiral carbide cutters, which we consider are essential.

Lubrication and cooling problems were more involved. We have found, in line with others, that as the cutting speed increases an increasing proportion of the heat is transferred to the chips, and above an optimum value sufficient heat is transferred to leave the cutter and workpiece at acceptable temperatures.

Therefore, the main problem was the lubrication of the cutting face to reduce friction, which both decreases cutting efficiency and causes the serious problem of chip welding, both factors which affect tool life.

The conventional method of directing a jet of lubricant on to the cutter is not very effective, due to the centrifuge action of the cutter preventing the lubricant reaching the cutting face; also, shop cleanliness is involved. Such a system complicates the design of the machine tool by having to provide for splash guards, drains, sumps and a circulating system. The problem was finally solved by generating an oil mist and passing this through the hollow spindle of the milling head, directing it to the cutting face through the cutter. This has proved to be a safe, clean and easily maintained method under actual production conditions.

Cutter efficiencies of 4 to 7 cu.in./h.p./min. have been obtained, the most efficient cutters being of the face mill type, where adequate spacing of the teeth can be provided to give smooth chip flow and to high rake angles. End mills are probably the least efficient due to the difficulty in obtaining a high rake angle on the spiral cutting edge, chip clearance problems and blending in of the spiral and end cutting faces. Also, the proportions of an end mill usually result in the cutting load being applied to the lower, unsupported part of the cutter, tending to result in vibration.

High Speed Milling Heads

We have produced three types of heads of the same rating, namely 10/20 h.p. at 3,000/6,000 r.p.m.

MK. 1. Angular contact ball bearings were used with fixed preload, lubricated by oil mist, which also provided a pressurised bearing chamber to prevent the ingress of foreign matter. This type of bearing proved to be unsatisfactory due to "Brinelling" of the ball races resulting from shock loads sustained when milling.

MK. 2. Spring preload on the bearings was incorporated. While giving greatly increased bearing life, axial movement of the spindle could result in variations on finish if the cutter load exceeded the bearing preload. This type of head (Fig. 21) has given very satisfactory service running at 3,000 r.p.m.

MK. 3. The improved head using hydrodynamic bearings, while still in the development stage, has given very encouraging results. This type of bearing is extremely rigid and is able to absorb shock loads.

A typical test — using 6″ dia., 3 blade carbide tipped face mill at 6,000 r.p.m. (9,000ft./min.) cutting light alloy DTD.683 bar, $3\frac{1}{2}$″ wide × ·3″ deep at 100″ per min. feed, gave an efficiency of 5·25 cu.in./h.p./min. with a very good surface finish. Light finishing cuts have resulted in a standard of finish of 5 micro inches C.L.A. A sample is exhibited.

A problem associated with this type of head is the effective sealing of the bearing oil. Face type seals are used at present, but at high speeds they cause power losses due to friction, with resulting high temperatures. Development work is being carried out on other types of seals.

Machine Tools and Control

The complexity of the type of component required for "Integral Construction" necessarily involves a copying facility. Manual control is impracticable for the efficient use of high powered milling heads, and therefore servo control is imperative.

At the time when the chassis rib was our major problem, hydraulic tracer control from templates appeared to be the only practical solution. New developments have changed this, and I will refer to these later.

A vertical column type milling machine, affectionately known as the "Green Linnet", with hydraulic copying system and incorporating two Mk.2 milling heads, was built and is in use on production of chassis ribs (Fig. 22).

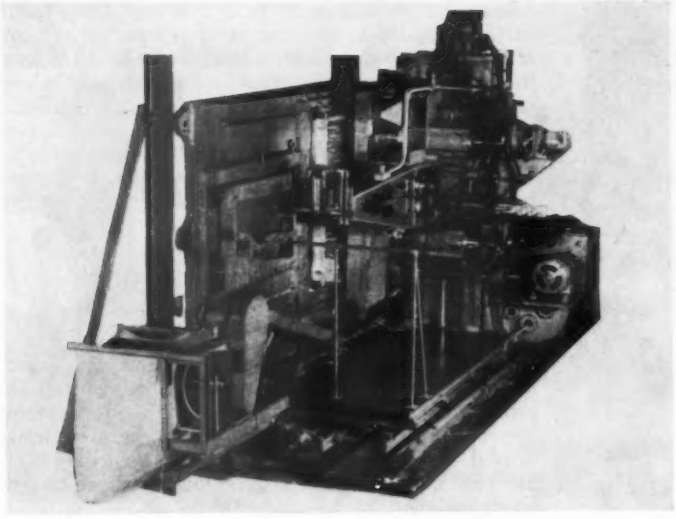


Fig. 22. Vertical column type milling machine (Green Linnet).

The capacity of the machine is 6ft. longitudinal traverse by 2ft. vertical movement. The vertical movement is hydraulically tracer controlled. The longitudinal traverse, though hydraulically actuated, is controlled by limit switches and set to the template.

Rough machining of the chassis rib leaves approximately 1/8″ metal all round for the final operation. Two ribs are machined at once, with a floor to floor time of approximately 4 hours. The amount of metal removed from a 205 lb. slab is 115 lb. (Fig. 23).

A conveyor belt is fitted to remove swarf.

The speed of the longitudinal traverse is infinitely variable between ·0 to 80″ per minute. The movement of the high speed heads, in and out, is by electric motor and operator controlled.

Parallel with the work carried out under the heading of necessity on the chassis rib, a wider investigation has been initiated, particularly with regard to the problem of control and its influence on machine tool design.

The choice of a control system depends on many factors, but for maximum economy the system must meet certain fundamental conditions. It must be capable of producing complex shapes involving sudden changes of profile at high machining rates to a relatively high standard of accuracy. Tooling costs and tool manufacturing time must be kept to a minimum. Also, the system must be flexible enough to allow component modification to be introduced quickly and easily. It must be simple to operate and reliable.

The choice lies between three basic systems :-

(I) Mechanical generating systems.

(II) Hydraulic and electronic template following tracer systems.

(III) Programme Control.

(I) Mechanical Generating Systems

These can only be considered for what are essentially single purpose applications, being incapable of completely machining any but the simplest of components.

(II) Hydraulic and Electronic Template Following Tracer Systems

Although widely used on machine tools, these have, in our opinion, been responsible for restricting the

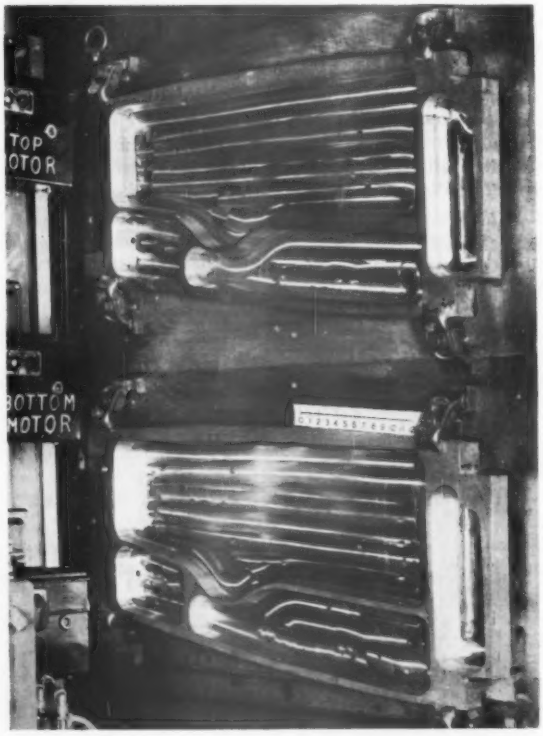


Fig. 23. Chassis ribs milled from stretched slabs.

wider application of servo-controlled machine tools in the aircraft industry for reasons of certain inherent disadvantages as follows :-

(a) The speed of profiling is limited by the permissible error, and the best tracing systems on the market work at speeds far too low for efficient high speed machining within the tolerances required.

(b) The production of accurate templates for complex shapes, itself, involves both time and high tooling cost where moderate quantities are required. Any inaccuracies in the template must be added to copying errors.

(c) The templates only govern the final shape of the component. All machining other than the final shape is subject to some degree of operator control, involving increased time and skill.

(d) Three-dimensional profiling involves a highly complex set up only justifiable where large quantities are concerned, and even then it is limited to the more simple shapes.

(III) Programme Control

We have used this heading for simplicity — it is intended to include computer control where the operation to be performed can be planned beforehand in full, and repeated at will from stored information.

I must point out that I am not going to attempt a description of programme control—Mr. Williamson, of Ferranti's has already dealt fully with this subject, both in articles in the technical press and in the many lectures he has given.

"Are we nearly there?" Alice managed to pant out at last.

"Nearly there," replied the Queen.

"Why, we passed it ten minutes ago!"

(With apologies to Lewis Carroll).

What I want to do, is to show where programme control overcomes the disadvantage of tracer control, and in so doing we believe offers a unique opportunity to the aircraft industry in its application to the complex machining operations which are increasing with the introduction of each new aircraft.

(a) The magnetic tape can supply advance information so that the cutter can travel at full speed around a contour and slow down only on approaching a sudden point of change ; in effect the machine will be operating at full traverse speed practically all the time within close limits.

(b) The magnetic tape is produced by a computer from drawing and planning information, in a fraction of the time for template production, thus reducing to a minimum the important gap between design and production.

(c) Since the cutter path is controlled all the time, roughing and cavity machining can be planned and controlled, thus eliminating operator control.

(d) The inaccuracies of template manufacture are eliminated since the computer works direct from drawing information.

(e) Programme control offers almost unlimited scope for further development, particularly in respect of complex shapes or curves.

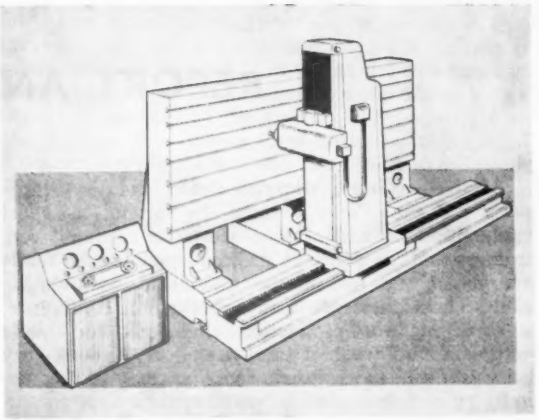


Fig. 24. 3-D high speed contour milling machine.

When a control system is applied to a machine tool, the machine tool becomes part of the control loop in which the overall response is governed by the least efficient member of the loop, so that a high response control system can only be applied to a machine tool with a high response factor.

Considerable design and development work has been carried out dealing with such problems as ideal slide conditions, minimum inertia considerations and backlash elimination, all factors which govern the ultimate performance of servo-controlled machine tools. Slide conditions have been tested and suitable slide arrangements designed. Drive units with backlash free gearing systems have also been designed to meet the requirements.

Future Developments

It is considered that the development of Integral Construction will take the form of sculpturing from slabs which are dimensionally larger than anything that has been achieved to date. We are convinced that stretched slabs are the answer, rather than the design being limited by the forging capacity available in this country. With limited quantities, the economics would also justify this decision.

Following this to its logical conclusion, we must have machine tools with Programme Control, which are non-existent in this country, and also for that matter in the United States.

We are about to begin actual manufacture of a 3-dimensional Programme Control Machine (Fig. 24) using the Ferranti Control System.

This machine is being backed by the Ministry of Supply and a contract has been placed for design, development and construction

The capacity of this machine is of interest :-

The longitudinal traverse is 25ft. and the vertical traverse of the column slide is 7ft. with a cross traverse of 12″. The table is adjustable to give increased capacity.

REPORT AND DISCUSSION

Mr. A. Vines, who presented the first three parts of the Paper, began by giving a short explanation of what it was that the Authors were trying to do. They were ordinary people who made aeroplanes and had no pretensions to be anything else. The Conference was a production conference, a conference of production engineers who made aeroplanes. They had tried, therefore, to look very briefly at the past, at what the aircraft production industry had done, and to examine their own organisation and the modifications which they had made as a result of experience during the War, and to look briefly at items of interest which they now had in their factories, bringing out points which would be of interest to those who made aircraft. The Paper was intended to provide a similar experience to that which would be gained by actually visiting their factories and seeing what went on there. He never went to a factory or to a conference without learning something, and the Authors hoped that from the Paper others would be able to learn at any rate some little thing which would help them to increase the efficiency of their own factories and to save time in the long run.

In presenting Part I of the Paper, Mr. Vines said that the only hope which he could see for the steady production of aircraft in this country was that goods should be carried by air as well as passengers. This was now the only country without a decent air freight service.

Dealing with Part II, he said that when they started with the idea of breaking up the jig and tool office and putting all the assembly development in the design office, they had had a measure of difficulty, but now that the design office had got used to the idea they found that it was one of the finest ways of solving detail design and general assembly problems, because the assembly development people tried to fit the aeroplane together as it was designed. They fitted the details of a particular component while the designers were designing it, so that if they did not like anything they could go to the design section while it was being drawn and ask for it to be modified; and at that stage the design office were far more likely to accept the suggestion than when the part had been completed. By that method the designers and the tooling people were able to learn, so that the benefit was twofold.

Mr. H. G. Gregory presented the remaining three parts of the Paper, which appears on pages 165/179.

Mr. Mark H. Taylor (*Managing Director, Taylor, Taylor & Hobson Ltd.*) opening the discussion, said that the Authors' bifurcated Paper had covered so much ground that it was difficult to know what to contribute. He would like to make one comment on the first part of the Paper, where Mr. Vines made a plea for having relatively small groups of people engaged on one job. It seemed to him that this was evidence of the practical engineer coming into his own again and proving that it was not for the 'accountant mind' to tell them what all the patterns of their activities should be. The 'accountant mind' would put forward the view that by having one large stores instead of three small ones it would be possible to save the wages of one man, but it was better to get the answer today than three answers the day after tomorrow.

It would be interesting to know whether Mr. Vines had found that by taking a small group of people and giving them a small variety of jobs, so that they could all grasp what was involved, and communication problems were cut down, men who had been in the 75 per cent. classified as lazy had become hard-working, so that in effect the percentages suggested by Sir Roy Fedden earlier were reversed. Mr. Taylor believed that whether men appeared to be lazy or effective was largely a matter of their environment and whether they understood what they were doing. By adopting Mr. Vines' suggetion and having small groups of men working together on a job which they could all understand, did not they tend to become efficient, hard working and interested instead of bored and frustrated?

Mr. Vines replied that from personal experience he could say that if one could get near enough to individuals to talk to them 99 per cent. — not just 90 per cent. — would respond and get on with the job. They had found that by having a design interest going right through to the foreman responsible for the component something of great value was obtained, because the foreman could tell the designer what he thought of him and get a mistake put right instead of having to complain about it afterwards. The same was true with stores. One could put a girl or an unintelligent type of man into a store where she or he could see the component being made and could understand it, and in a month or so such people would learn all about it and take much more interest in the store. During the War that proved very effective.

Mr. W. A. Sales (*Director of Aircraft Production Development, Ministry of Supply*) asked Mr. Vines to explain the big advantage which accrued from the man who was actually faced with the problem of machining being in a position himself to solve his own difficulties, rather than having to present it to a separate team of designers, as had to be done when going to a machine tool firm.

Mr. Vines said that they had done this by necessity, because when they came along at the end of the queue on the last aircraft to be put into production they could not get any assistance from the machine tool trade, who had been far too busy. They had at that time at Stockport a small group who had previously done some work on machine tools. Slides had been shown of the type of machine tool which they had produced. They had done a similar type of job from Hayes. The advantage was that one got what one wanted, when one wanted it, far more easily than when it was necessary to ask someone else to do it. If a firm had a facility, however small, to adapt and modify and build machines it was a tremendous advantage. It would not pay in a normal aircraft firm, but if a firm had flexibility — and far more could be done by being flexible — it added tremendous interest to the work of those concerned with tooling development, who when they were slack on aircraft work could take up this other work.

Mr. Sales, pursuing the point further, asked whether Mr. Vines thought it would be feasible, by some system yet to be devised, to bridge this gulf. He agreed entirely with what Mr. Vines had said, and thought that there was a distinct advantage in the man who had the problem solving it, but it was not possible for the aircraft industry completely to absorb the machine tool industry, so that in some way or other it was necessary to find a solution for the problem and find a formula. He was looking for it, and he thought that he had part of it.

Mr. Vines replied that the formula was quite simple : it was the Treasury. In the past, the Ministry of Supply had been handicapped in placing contracts for machines and equipment to develop a process which was not backed up by a big production order. If they were going to have small quantity production and could not get big quantities of civil air transport aircraft to make, they would not have big production orders and must rely on the odd twenty machines. They would lack money and time, because nowadays the machine was wanted almost as soon as the specification was issued. It was necessary, therefore, to have a production ministry with the courage and authority to enable the aircraft industry to have the special types of machining equipment necessary, on the lines of what was done in America. He thought that the Ministry would like to do that, and that all that had stopped them in the past was lack of money. If they went to the machine tool industry and said : " We want a machine of this type and are prepared to pay for it ", the machine tool industry might be interested, instead of saying : " We have five years' work on hand. We do not make any money out of you, and we are not interested. Good afternoon."

Mr. Sales said that as a matter of fact that was what he wanted. He was afraid that he would have to stop there because of certain difficulties. The matter was of great importance. He was sure that the time would come eventually when the problem would have to be faced. They hoped to be able to have a very fine co-operative spirit between the two trades, so that the right man did a particular job. He thought it would be made to work. He could not mention any names, but recently he had been approached by an important member of the machine tool industry who was putting this remedy into effect by the special appointment of a man who had been faced with these problems. That was probably the solution.

Mr. W. S. Hollis, B.Sc.(Eng.), A.F.R.Ae.S. (*Assistant Director, Aircraft Production Development Directorate, Ministry of Supply*) said he thought that the aircraft industry would always be faced with a need for machine tools of a speculative character. The speculation arose perhaps on the size of the order, or the usefulness of the machine tool itself might only be temporary. The current risks depend on changing from light alloy to steel, sandwich or integral methods to a different method of manufacture arising from a change in aircraft plan form. He thought that in fairness the machine tool industry could not be asked to provide in their range machine tools of that sort. On the other hand, they were sometimes faced with schemes recognisable as providing the basis for a demand in machine tools, or methods, of which the best example was perhaps the stretch press. That had been evolved in this country, and excellent development of its principles had been carried on in America; someone had made a lot of profit. He hoped that with the development now under discussion the same thing would happen. Here was the basis of a very good machine tool, and he hoped that it would be produced in this country.

The **Chairman** said that with no disrespect to the Authors or to the Paper it would be necessary, in view of the lateness of the hour, to close the discussion. On behalf of the whole Conference he wished to thank the Authors for a wonderful Paper.

Mr. H. G. Gregory, on behalf of Mr. Vines and himself, thanked the Conference for the appreciation which they had expressed. He was sorry that there had not been more time to discuss the Paper, because figures had been given which had not been quoted elsewhere in the technical press. When the Paper was read, and the samples and standard of finish examined, he thought it would be agreed that the result was remarkable. There was nothing in America today to compare with it. He did not refer so much, in saying that, to the trepan borers, because that was the development of the German head after the last War, but to the contour machining and the stock removal rates, the efficiencies of which had not been attained in America. That should always be borne in mind when reading about and seeing photographs of American contour three-dimensional machining. The Americans were not getting anything like the same speeds and feeds. The approach which had been described to jigging problems, special purpose machine tools and three-dimensional machining could save time.

The Conference then adjourned until the following day.

CASE STUDY No. 2
Toolstores Layout

An example of the use of string diagrams as an aid to a Materials Handling study in the Toolstores.

Circumstances. *Management of the firm in question were aware that unnecessary handling was taking place in the Toolstores when issues were being made and that in addition time was being wasted by higher grade employees whilst waiting for service at the counter. Before giving sanction for an increase in toolstores personnel, it was decided that an investigation be carried out to assist in deciding whether a further storekeeper was necessary.*

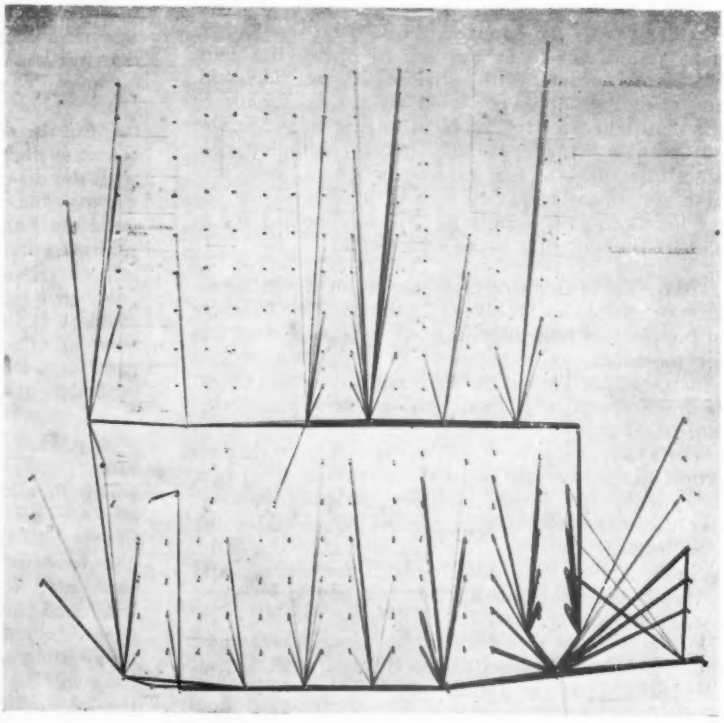
Approach. *The investigation commenced with an observation over a period of two days, during which the movement of the Storekeeper between the serving hatch and the storage bins, etc., was recorded. A scale drawing was made of the Stores area showing the exact location and contents of each bin. This drawing was then mounted on a timber backing board with nails located at each bin and gangway intersection. Commencing at the serving hatch the recorded movements of the Storekeeper were plotted with a length of cotton using the nails as anchor points.*

Detailed examination of the completed diagram indicated considerable movement to the rear portion of the Stores, thus revealing that certain "high turnover" items were situated some distance from the serving hatch. It was realised that considerable benefits would accrue if the Toolstores layout were replanned taking into account the frequency with which the Storekeeper visited each storage bin.

old method

The photographs below and on the facing page show the existing layout and recommended layout of the Toolstores. The dots on the photographs are nails located at each bin, forming an anchor for the string, which represents the path of movement of the storekeeper in carrying out his duties. Both photographs show the activities of the storekeeper over the same period.

EXISTING LAYOUT



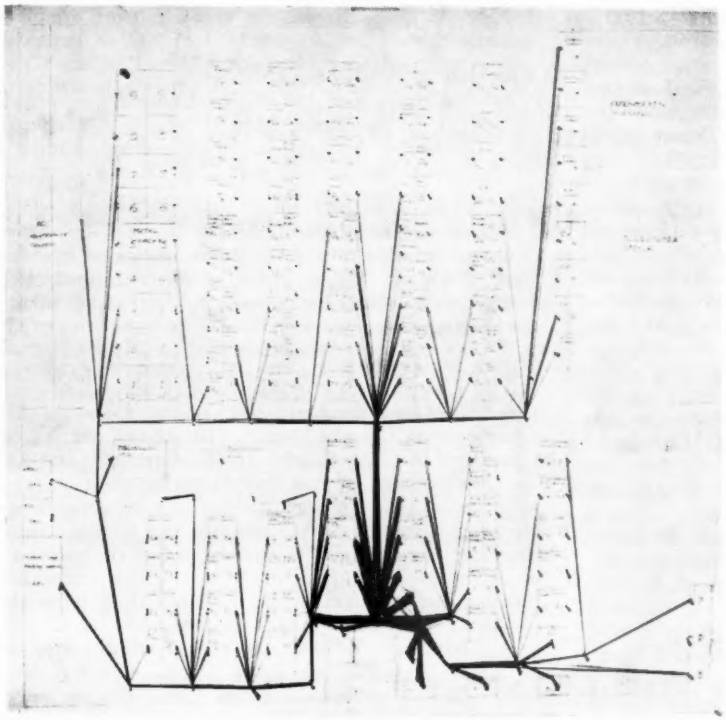
String diagram of existing Toolstores Layout.

Length of string	... ...	326 yards.
Distance travelled in 2 days	...	4.45 miles.

HANDLING

new method

NEW STUDY LAYOUT



String diagram of New Toolstores Layout.

Length of string	214 yards.
Distance travelled in 2 days ...	2.92 miles.
Distance saved annually	765 miles.
Time saved annually	383 hours.

Procedure. The layout of the Stores was then re-drawn incorporating the following changes :

1. All bins containing "high turnover" items located nearer the serving hatch.
2. A repositioned serving hatch.
3. A central gangway.

Every endeavour was made to ensure that bins containing items of a similar nature were kept together, i.e. Spares for Machine Tools, etc. Consideration had to be given to the security measures in force, i.e. an unobstructed view through the Stores. The revised layout was also mounted on a timber backing board and nails located at bins and intersections. *Using the same observations as for the previous diagram* a string diagram was prepared of the recommended layout.

Results. Examination and comparison of the two string diagrams revealed that the lines of greater density had been considerably reduced in length, a direct result of repositioning bins of "high turnover" items, and of the central serving hatch. Whereas in the original layout the lines of greater activity covered the whole stores area, they are now confined to the immediate surroundings of the serving hatch in the new layout. The string was then unwound from each diagram and measured revealing the following facts :

	Existing Layout	*New Layout*
1. Length of string	326 yds.	214 yds.
2. Distance travelled by Storekeeper in two days ...	4·45 miles	2·92 miles
Distance saved in two days	1·53 miles.	

Summary. Direct results of the introduction of the Work Study layout are :

1. Handling time saved annually ... ... 383 hours.
2. Movement of storekeepers eliminated annually ... ... 765 miles.

Percentage saving 34.4%.

Resulting in :-

1. Quicker service at the Toolstores.
2. Less time spent waiting for service.
3. Less time spent by personnel away from their departments, resulting in increased efficiency through a reduction of Idle Time.

REPORT OF THE ANNUAL GENERAL MEETING

Thursday, 26th January, 1956.

THE thirty-fourth Annual General Meeting of the Institution was held on Thursday, 26th January, 1956, at 2 p.m., at the Headquarters of the Institution, 10 Chesterfield Street, London, W.1. The President-Elect, Mr. E. W. Hancock, M.B.E., was in the Chair.

Notice convening Meeting

The Secretary (Mr. W. F. S. Woodford) read the notice convening the meeting.

The Chairman said he regarded it as a privilege to be occupying the Chair again at an Annual General Meeting. It was many years since last he had had the honour of doing so. The best method which he could adopt of acknowledging the honour was to say as little as possible, but to continue to give what little support he could and what little energy he had left to the interests of the Institution!

Apologies for Absence

The Secretary said that the President, Sir Leonard Lord, had intimated that he was very sorry not to be able to be present and take the Chair. Many other apologies had been received from members.

Minutes

The Minutes of the previous Annual General Meeting, held on 27th January, 1955, which had been published in the January *Journal,* were taken as read and confirmed on the motion of Mr. B. G. L. Jackman, seconded by Mr. F. T. Nurrish, M.B.E., and were signed as correct.

Election of Members to Council

The Report on the Election of Members to Council was received on the motion of Mr. C. C. Cornford, seconded by Mr. W. Abraham.

Annual Report of Council

Mr. G. R. Pryor (Chairman of Council), in moving the adoption of the Annual Report, said he had hoped that more members would be present, so that he could emphasise to them the effect of the new rates of postage. The postage of the *Journal* was going to cost another £3,000 in a full year, and other postage an additional £500 a year, which was equivalent to a yearly levy of 7s. 6d. per member. The Finance and General Purposes Committee would have to consider that very seriously and see how the difficulty could be overcome.

On the penultimate page of the Report (page 61 of the January *Journal*) he had referred to the very valuable services given to the Institution by many members. He was sorry that he had not been more definite, and feared that he might have given offence. He would like to correct that, therefore, by making specific reference to all the Section and Regional Honorary Secretaries and other Section and Regional officers, and also to all lecturers, both local and national. A great debt was due to these gentlemen, and it was possibly not courteous to refer to them in an omnibus way in one paragraph together with others.

Another item omitted from the Report, which most of the members would know but which those who did not know it would be glad to hear, was that Sir Walter Puckey had been appointed Chairman of the Board of Studies (Engineering) of Lord Hives' Council for the National Award in Technology.

Mr. H. G. Gregory seconded the motion, which was carried unanimously.

Statement of Income and Expenditure, Balance Sheet and Auditors' Report

On the motion of Mr. H. G. Gregory, seconded by Mr. A. Betts Brown, the accounts were adopted unanimously.

Election of Auditors, 1955-56

On the motion of Mr. F. W. Cranmer, seconded by Mr. A. S. Johnstone, Messrs. Gibson, Appleby & Co., Chartered Accountants, were elected Auditors to the Institution for the year 1955-56 and thanked for their previous services.

Election of Solicitors, 1955-56

On the motion of Mr. H. Burke, seconded by Mr. E. P. Edwards, Messrs. Syrett & Sons were elected Institution Solicitors for the year 1955-56 and thanked for their previous services.

Votes of Thanks

The Chairman moved a vote of thanks to the immediate Past President (Sir Walter Puckey), the Chairman of Council (Mr. G. R. Pryor), the Vice-Chairman of Council (Mr. H. G. Gregory), and all the other officers of the Institution for their leadership and conduct of the Institution's affairs during the year. In the deliberations of the Council that morning, he said, it had been stated that the main object of the Institution was to benefit the individual member, and there could be no doubt that the work of the Council was directed to that end; but in all these activities — he had noticed this all his life, as no doubt they all had — there were always a few outstanding, unselfish, competent men who not only did their day's work, but then proceeded to do another day's work on the top of it in the interests of their fellow men.

At the Annual General Metting it was only fitting that genuine public tribute should be paid to those members of the Institution who had carried it through the last year so successfully. There was no doubt about the Institution's success, and there was no doubt about the individuals who had been the leaders in promoting that success. He would like to mention two or three of them, so that their names would be on permanent record.

First, there was the immediate Past President, Sir Walter Puckey. There was no doubt that he was a great man. He had probably done more good than he would ever realise in building up enthusiasm, apart from the specific carrying out of his duties. They could all learn from him. He had guided the Institution not only as its figurehead but in various ways throughout all its activities, and it was a real pleasure to the Chairman to propose a vote of thanks to him for his work.

Secondly, they would all desire to have mentioned the name of Mr. G. R. Pryor, the Chairman of Council, who had carried the flag for his second session. During the year under review he had been a real stalwart. "He has," the Chairman remarked, "the ability to disagree with you and yet make you think that he is on your side." He had shown that it was better to be friendly with people than to fight them. His words of wisdom had lubricated the activity of the Institution during his year of office and he deserved cordial thanks for all the work that he had done on behalf of the Institution.

The Chairman also wished to make particular reference to Mr. H. G. Gregory, the Vice-Chairman of Council. The Chairman felt that he must be on very friendly terms with Mr. Gregory in view of future events, but, if only half the things that he had heard about Mr. Gregory were true, he was going to have a very easy time when he took over the Presidency.

He wished to include in the vote of thanks all the other officers of the Institution, whatever their position, who were doing voluntary work for it, work which was not absolutely necessary but which they felt to be in the general interests of the community, of engineers, and of production engineers in particular. He wished also to include in the vote of thanks the staff of the Institution. Ever since he could remember, from the days when he had been one of three members who selected Richard Hazleton as the first full-time Secretary, the staff had never ceased to be 'bullyragged' by somebody, but life was like that. There were only two things absolutely certain about life: one was death and the other trouble! The job of the permanent staff at headquarters had been full of trouble and difficulty, but he would like to thank them for the work which they had done during the year in spite of all the difficulties. He wished in particular to thank their worthy Secretary, who, he was glad to see, was still able to fight back; he liked that fighting spirit. He hoped that the Secretary would convey their thanks right down to the most junior member of the staff, and wished to conclude his remarks by thanking the meeting for listening to him so patiently.

Mr. E. N. Farrar said that it was a privilege to second the vote of thanks, and he only regretted that he had not Mr. Hancock's gift of speech. He heartily endorsed everything that Mr. Hancock had said.

The vote of thanks was carried by acclamation.

Mr. G. R. Pryor, responding, said he was sure that Sir Walter Puckey would wish to join with him in expressing appreciation of what had been said. For himself, all he could say was that he was fortunate enough to have reached a time of life when he did not look for trouble or feel it necessary to do anything that he did not want to do. What he had done for the Institution had not only given him great pleasure, but had been most rewarding. That was very significant. The little that any of them could do for the Institution came back to them tenfold by the way in which it helped them to educate themselves and broaden their minds. As he came to the end of his period of office he felt that he owed a very great debt to the Institution and to the Council and to all the good friends that he had made.

Mr. H. G. Gregory, who also responded, expressed his gratitude for the kind words which had been said and for the way in which they had been received by the meeting. The coming year, he said, might be a very important one in the life of the Institution. He could only promise to do his best; if he failed, it would not be intentional.

Mr. J. E. Hill, in moving a cordial vote of thanks to Mr. Hancock for taking the Chair, which was carried by acclamation, said that they were all glad to see him back in harness in the Institution. He regarded it as evidence of the esteem in which the Vice-President was held in the Institution and amongst production engineers that to most of them he was known as "Bill Hancock".

The meeting then terminated.

REPORT OF THE MEETING OF COUNCIL

Thursday, 26th January, 1956

THE third Council Meeting of the 1955/6 Session was held at 10 Chesterfield Street, London, W.1, on Thursday, 26th January, 1956. The meeting, at which the Chairman of Council, Mr. G. Ronald Pryor, presided, was attended by 26 members, and the following were present by invitation :-

Mr. A. Betts Brown, Chairman, Edinburgh Section; Mr. F. H. Johns, Chairman, London Graduate Section; Mr. D. S. Redhead, Hon. Secretary, South Essex Section; Mr. T. F. Newton, Hon. Secretary, Sheffield Section; Mr. H. Wright, Hon. Secretary, Lincoln Section.

In welcoming the above to the meeting, the Chairman expressed regret that Miss N. E. Bottom, Hon. Secretary of the Halifax Section, was unable to attend because of illness, and said he was sure that the Council would wish to send to her sympathy and best wishes for a speedy recovery.

The President-Elect

The Chairman said it gave him great pleasure to welcome to the meeting the President-Elect, Mr. E. W. Hancock, M.B.E., Hon.M.I.Prod.E. Mr. Hancock was a great stalwart of the Institution, and one of its elder statesmen, and they were very fortunate indeed that he had agreed to accept office as President.

Mr. Hancock, in a brief response, thanked the Council for the honour they had done him, and gave an assurance that he would do all he could to further the work of the Institution.

Finance

The Chairman drew attention to the serious effect on the Institution's budget of the new postage rates, which would mean an increased cost of approximately £3,500 in a full year, of which £3,000 was the additional cost of posting the Journal. The Finance and General Purposes Committee intended to give consideration to this problem at their next meeting.

Automation

It was reported that arising from the discussion at the October Council Meeting, an ad hoc Committee had been set up to investigate the implications of automation in the broader sense. Particular attention would be paid in the first instance to the effect of automation on human relations in industry and in society. The members of this Committee are :—

A. F. Kelley (Chairman); Sir Francis Brake; B. H. Dyson ; J. R. Gass (D.S.I.R.) ; Lord Halsbury (N.R.D.C.); Sir Thomas Hutton (B.P.C.); G. R. Pryor ; Sir Walter Puckey ; M. Seaman ; R. Telford ; and F. G. Woollard, M.B.E.

Production Exhibition and Conference, 1956

It was reported that the Advisory Committee had held regular monthly meetings, and that arrangements for the Conference programme were almost complete. In addition, over 60% of the space available at Olympia had been taken up.

The British Productivity Council was co-operating in the Exhibition by asking each of their Local Productivity Committees to arrange a small exhibit showing first-class examples of improved productivity from firms in their particular area.

Conference of University Professors

The Secretary reported that arrangements for a small Conference of European professors of production engineering were proceeding. A small ad hoc Committee had been formed under the chairmanship of Sir Walter Puckey. The proposal was that a small delegation from the U.K. should spend four or five days in Europe, with headquarters probably in Delft, to discuss with the appropriate authorities the teaching of production engineering at University level.

Southern Section Aircraft Conference

It was reported by the Secretary that there was a capacity attendance at the successful Fourth Annual Conference on the Problems of Aircraft Production, held at Southampton in January and, in fact, a number of applications had had to be returned.

A feature of this Conference was the inauguration of the Lord Sempill Paper, presented by Sir Roy Fedden, on " Britain's Aircraft Needs ". This session was filmed by a B.B.C. Television Unit.

Higher Technological Education

It was reported that the Board of Engineering Studies, under the Council for the National Award in Technology, had held their first meeting, and had elected Sir Walter Puckey as Chairman. Sir Walter had also been nominated to serve on the Council.

Broadening of the Base

The Education Committee reported that a joint conference with the Membership Committee, the Finance and General Purposes Committee, and other senior members, had been held on 22nd October last, presided over by the Chairman of Council. The meeting adopted the following resolution :—

" That complete exemption from Parts I and II of the Associate Membership Examination be granted to corporate members by examination of acceptable professional Institutions, provided such persons hold or have held adequate managerial status on the production side."

The Education Committee proposed to accept the Institutions of Civil, Mechanical, Electrical and Chemical Engineers on the above basis academically, and were examining other Institutions.

A Sub-Committee had been appointed to draft proposals on the Associate Membership Examination.

Summer School 1956

The Summer School will be held at Ashorne Hill from 25th to 29th July, 1956, on the theme : " Education for Automation ". The President-Elect, Mr. E. W. Hancock, M.B.E., has been invited to give the opening address.

Membership

The Committee reported with great regret the resignation of Mr. H. Tomlinson, due to pressure of business, and expressed warm appreciation of his past services.

The Council approved a number of applications for membership and transfer, details of which appear on pages 188/189 of this Journal.

The Journal

It was reported by the Editorial Committee that the series of leading articles on " Designing for Production " was attracting a great deal of interest. The most recent contribution was by Sir Herman Lebus, C.B.E., on designing for production in the furniture industry.

Following discussions with the printers and the advertising agents, recommendations were made, and approved by the Finance and General Purposes Committee, that the advertising rates for the Journal should be increased, and a less expensive paper used for advertisements. By this means, considerable savings would be effected.

Institution Papers

The following report was made by the Papers Committee :-

The 1955 Viscount Nuffield Paper was presented at the Royal Institution on 15th December, 1955, by Dr. G. H. Daniel, of the Ministry of Fuel and Power. His subject was " Britain's Energy Prospects ", and the Paper created considerable interest. There were a large number of visitors present, among whom was Sir John Cockcroft, Head of the Atomic Energy Research Establishment at Harwell, who took part in the discussion.

The 1955 Sir Alfred Herbert Paper would be presented at the Royal Institution on 9th February, 1955, by Dr. N. H. Mackworth, of the Medical Research Council Applied Psychology Research Unit at Cambridge, whose subject would be : " Work Design and Training for Future Industrial Skills "

The 1955 George Bray Memorial Lecture. This Lecture would be presented at the Royal Institution on 7th March next. The subject would be : " Pride in Workmanship : Today's Challenge ", and the speaker would be Sir Gordon Russell, C.B.E., R.D.I., Director of the Council of Industrial Design.

Research

The following reports were made on behalf of the sub-committees of the Research Committee :-

Materials Handling. The Sub-Committee had appointed, jointly with the Education Committee, a Working Group to prepare a Syllabus and Examination for an advanced Materials Handling course.

A series of case studies for publication in the Journal had been prepared, and the first study appeared in the December issue.

Arrangements were being made for a showing of selected materials handling films, with discussions, in Birmingham in March, 1956.

Sources of Information. The Sub-Committee were now engaged on the long and necessarily slow process of reducing to a common formula the several hundred entries in the proposed directory.

Material Utilisation. The Report of this Sub-Committee having been published, the Research Committee had decided to initiate investigations into other aspects of material utilisation, as follows :-

Finishing (painting, enamelling, lacquering, chemical finishes and plated finishes).

Ancillary materials, with particular regard to packaging, cartoning and shipping materials.

Alternative materials (e.g. powder metallurgy, plastics, ceramics, etc.).

Indirect materials (e.g. degreasing solutions, wetting agents, lubricants, cutting oils, etc.

Production Control. The Report of this Sub-Committee had now been published.

Quality Control. The Research Committee had been asked by the British Productivity Council to nominate a representative on its informal committee on Quality Control. Mr. S. W. Nixon had agreed to undertake this work. The Research Committee had also asked Mr. Nixon to form a Sub-Committee on the Control of Quality, and this was being done.

Joint Committee with I.C.W.A. A meeting was being arranged at which the terms of reference and future activities of the Joint Committee would be discussed.

Standards

The Committee reported that as a result of its efforts, the question of further publicity for I.S.O. recommendations was to be raised at the next Council Meeting of the British Standards Institution.

The Committee were also preparing a detailed report on cutting tool nomenclature showing the extent to which there was dissatisfaction with the existing Standard.

The Council adopted the Committee's recommendation that the B.S.I. be asked to start work on the standardisation of spindle units for transfer machines.

Joint Examination Board

The Council adopted unanimously the recommendation of the Finance and General Purposes Committee that there should be placed on record the keen appreciation of the Council of the valuable services rendered to the Institution by Mr. J. W. Berry, during his many years' continuous service as Chairman of the Joint Examination Board. During this period, the Institution had been granted professional status as a result of the untiring efforts of the Board under Mr. Berry's leadership.

Hazleton Memorial Library

It was reported that the Catalogue had now been published. The Committee were proposing to examine the book selection policy in view of the widening scope of enquiries, but had decided to postpone discussion of the subject until the effect of the publication of the Catalogue was known.

Local Section Reports

The Councils received a number of Regional and Local Section Reports, extracts from which appear on pages 189/194 of this Journal.

Liaison with Overseas Sections

The Vice-Chairman of Council, Mr. H. G. Gregory, reported that he was in receipt of a letter from the Australian Council, asking for more detailed guidance in assessing applications for membership. A full discussion took place on this matter.

Mr. Gregory also reported that the Chairman of the Canadian Section, Mr. C. J. Luby, had expressed appreciation of the revised policy regarding Canadian applications for membership.

Mr. Jack Merkine, the Institution's corresponding member in the Middle East, had very kindly presented Headquarters with an Oriental bowl.

Honours

The Council noted with pleasure that H.M. the Queen had conferred the following awards on members of the Institution :-

K.B.E.

Sir Claude Gibb, Member.

C.B.E.
Mr. J. H. Larrard, Member.
O.B.E.
Mr. F. H. Perkins, Member.
M.B.E.
Mr. A. L. Beech, Member.

Obituary

The Council recorded with deep regret the deaths of the following members :-

Members
H. Barrand ; R. Blackburn ; G. C. Trowbridge ; A. W. H. Walker.

Associate Members
C. V. Binding ; J. E. V. Crumpton ; M. Moss ; E. C. Willmott ; N. Wood.

Graduate
A. M. Ray.

Student
A. G. Davies.

Date and Place of Next Meeting

It was agreed that the next meeting of Council should be held at 10 Chesterfield Street, London, W.1, on Thursday, 26th April, 1956.

It was also agreed that the meeting of Council provisionally arranged for 26th July should be brought forward to 19th July, 1956.

Regional Organisation

Following the general business of Council, a discussion took place on the Regional organisation of the Institution and its progress to date.

Contributions to the discussion were made by members who had attended the Conference of Regional Officers held the previous evening, and the general opinion was that in spite of some local difficulties, regionalisation was working well.

In closing the discussion, the Chairman said he was sure that regionalisation could give members of the Institution an opportunity to look at a different type of problem and a different horizon from those which were common in Sections.

ELECTIONS AND TRANSFERS

26th January, 1956.

The following were elected to membership by Council:

BIRMINGHAM SECTION

As Associate Members
A. P. James, F. J. Withers.
As Graduates
A. E. Cooper, F. R. Cooper, A. J. Harvey, S. W. Hemming, G. R. Hooper, G. W. Jackson, T. Mathew, J. Price, K. N. Sapru, P. C. Smith, V. C. White, M. J. L. Willison.
As Students
C. C. Blyth, M. J. England, P. Fineman, R. M. T. Page.
Transfers
From Associate Member to Member
D. B. Bowen.
From Graduates to Associate Members
T. H. Jeens, D. R. G. Nash, G. D. Parker, L. Tolman.
From Student to Graduate
J. A. Durrant.

BOMBAY SECTION

As Students
A. K. Bose, M. N. Das, R. P. Kakkar, R. Prasad.
Transfer
From Associate Member to Member
A. Miller.

CALCUTTA SECTION

As Students
B. K. Bhattacharjee, M. Nagaraj.
Transfer
From Graduate to Associate Member
K. L. Bhala.

CANADA SECTION

As Member
T. M. Hutchinson.
As Associate Member
H. S. Webber.

COVENTRY SECTION

As Associate Member
R. J. Cornelius.
As Graduates
D. J. Brown, W. B. Chandler, M. G. Cherry, M. C. Lewins.
As Students
C. Kemp, R. S. Riley.

DERBY SECTION

As Graduates
D. M. Hunter, H. Butler, W. J. Brown.
As Students
K. E. Cockbill, A. A. Taylor, M. V. Turner, W. Whittaker.
Transfers
From Associate Member to Member
R. K. Grunau.
From Graduate to Associate Member
D. O. Boden.
From Students to Graduates
J. H. Cox, E. Lancashire.

EASTERN COUNTIES SECTION

As Graduate
A. K. Gill.
As Student
J. C. Taylor

GLASGOW SECTION

As Associate Member
S. S. Chang.
As Graduate
L. Currie.
As Student
K. R. MacIntyre.
Transfers
From Associate Member to Member
J. C. Holmes.
From Graduate to Associate Member
R. D. Lang.
From Student to Graduate
A. C. Bell.

GLOUCESTER SECTION

As Student
D. A. J. Revell.
Transfer
From Graduate to Associate Member
C. L. Mawhood.

HALIFAX SECTION

Transfer
From Student to Graduate
A. D. Bailey.

LEICESTER SECTION

As Member
E. A. Chapman.
As Associate Member
S. W. Deane.
As Graduates
D. S. Oliver, M. J. Walsh.
As Student
K. Wren.
Transfer
From Associate Member to Member
D. F. M. Griffiths.

LINCOLN SECTION

As Associate Member
W. Steele.
As Graduate
A. J. Grantham.
As Students
T. G. Brinded, G. Phillips.

LIVERPOOL SECTION

As Students
J. Atherton, L. W. Butler, J. F. Cliffe, J. J. Code, R. G. Cox, M. Green, J. R. Jones, L. Jones, R. A. Reeves, K. Smith.
Transfers
From Associate Member to Member
A. O. Mattocks.
From Graduate to Associate Member
C. Cameron.
From Students to Graduates
C. E. Copeland, G. D. Kendrick.

LONDON SECTION

As Member
G. D. Sparrow.
As Associate Members
E. D. S. Baker-Carr, S. E. Blackstone, A. B. O'Connor, P. G. J. Sargent.
As Graduates
G. H. Briscoe, R. H. Dodgson, G. D. Evans, T. G. Jones, P. W. Millyard, A. C. Porter, G. Tah.
As Students
J. M. Aubrey, R. H. Banks, P. Bargh, D. A. Barratt, V. J. Basham, B. R. Boyle, E. H. Dennis, R. Dowling, M. Harding, D. W. Hicks, D. W. Minett, J. M. Viol.
Transfers
From Graduates to Associate Members
R. Ball, D. Birrell, W. M. Bull, L. E. B. Corr, J. C. Crockett, P. E. J. Edwards, A. V. Gilbert, L. C. Hodges, K. D. Park, G. L. Rogers, G. D. Shaw, K. J. Swinson, C. F. G. Williams.
From Students to Graduates
G. S. Cheeswright, B. C. Haas, R. E. Thompson, H. P. Warren.

LUTON SECTION

As Member
A. H. Carding.
As Graduates
B. Butterfield, L. E. Fishburn, S. Y. Jakatdar, S. J. H. Wintle.
Transfers
From Associate Member to Member
J. L. Gwyther.
From Graduates to Associate Members
J. A. Seager, A. W. Stannard.
From Student to Graduate
E. J. Scanes.

MANCHESTER SECTION

As Member
H. Wright Baker.
As Graduate
G. Taylor

Transfers
From Graduates to Associate Members
H. Bibby, P. C. Bradshaw, R. Davies, H. Haughton, H. T. Lossius, D. D. Shrewsbury.
From Students to Graduates
A. Etchells.

MELBOURNE SECTION

New Affiliated Firms	New Affiliated Reps.
Brass Co. of Aust Pty. Ltd.	H. Stewardson, S. J. Stewardson.
Department of Defence Production.	H. G. Ball, B. H. Arndt.
Electronic Industries Imports Pty. Ltd.	D. Dryden, N. W. North.

NEW ZEALAND SECTION
As Associate Members
P. G. H. Newton, S. McLean Wallace.
As Student
D. A. Crawford.
Transfer
From Associate Member to Member
H. K. Pickering.

NORTHERN IRELAND SECTION
As Graduate
R. H. Alany.

NORTH EASTERN SECTION
As Graduate
A. James.
Transfer
From Graduate to Associate Member
D. M. Anthony.

NOTTINGHAM SECTION
As Students
K. C. Smith, J. T. Whitworth.
Transfers
From Graduate to Associate Member
W. E. Herring.
From Students to Graduates
K. E. Clavering, B. C. Jessop.

NORWICH SECTION
As Student
J. E. Webb.
Transfers
From Associate Member to Member
R. E. Copelin.
From Graduate to Associate Member
N. Sherrington.

OXFORD SECTION
As Member
R. Robertson.
As Student
M. F. Jones.
Transfer
From Graduate to Associate Member
R. E. Peckham.

PETERBOROUGH SECTION
As Associate Member
J. J. Nowak.

PRESTON SECTION
As Member
N. Tattersall.
As Associate Member
G. Skinner.
As Graduates
A. Birtwistle, F. B. Leak, F. Rowland, G. G. Williams.
As Students
F. Burnett, J. Cartwright, H. Cottam.
Transfers
From Graduate to Associate Member
H. Shepherd.
From Students to Graduates
F. S. Haydock, R. J. Hindle.

READING SECTION
As Member
V. L. Rye.
As Associate Members
R. S. Bumstead, H. Woolley.
Transfers
From Students to Graduates
W. A. Matthews, F. J. Moore, J. P. B. Newton.

ROCHESTER SECTION
As Member
B. Kaiser.
As Graduate
E. E. Dove.
As Students
D. M. Samson, J. M. Webb, B. J. Wolford.
Transfer
From Student to Graduate
D. E. Bolwell.

SHEFFIELD SECTION
As Student
V. S. Eltringham

SHREWSBURY SECTION
Transfer
From Associate Member to Member
W. Castledine.

SOUTH ESSEX SECTION
As Member
W. C. Brown.
As Graduates
H. W. Smith, E. C. Williams.
As Students
J. L. Davies, F. J. Egenolf, J. R. Gulliver.
Transfers
From Graduates to Associate Members
E. A. Castle, J. J. Dyer.
From Student to Graduate
D. Cowper.

SOUTH WALES SECTION
As Associate Member
A. F. Radford.
Transfers
From Associate Member to Member
W. Abraham.
From Graduate to Associate Member
A. G. Low.
From Student to Graduate
T. J. Northall.

SOUTHERN SECTION
Transfer
From Associate Member to Member
C. Sumner.

STOKE SECTION
As Graduate
J. Bates.

SYDNEY SECTION
As Graduate
W. H. Landmann.
Transfer
From Associate Member to Member
H. A. Turner.

TEES-SIDE SECTION
As Member
W. G. Roberts.
As Student
T. C. Bates.
Transfer
From Graduate to Associate Member
G. Hayes.

WESTERN SECTION
As Member
R. H. Capp.
As Associate Member
M. Paine.
As Graduates
K. A. Crago, M. J. Leonard, R. J. Parkhouse.
As Students
A. D. White, K. Mc. K. White.
Transfers
From Graduates to Associate Members
J. A. Freel, E. L. J. Hobday.
From Student to Graduate
R. Friendship.

WEST WALES SECTION
As Students
D. L. Allen, J. H. Parsons.

WOLVERHAMPTON SECTION
As Graduates
W. A. Body, J. H. Cotton, K. G. Wilson.
As Student
B. Farazmand.
Transfers
From Graduates to Associate Members
R. J. Evans, P. H. C. Waddington, S. J. H. Wilkes.

WORCESTER SECTION
As Associate Member
P. L. Coad.
As Graduate
D. H. Greenhill.
As Students
D. E. Aldridge, P. St. John Henman, D. R. Johnson, R. W. J. Wright.

YORKSHIRE SECTION
As Member
C. K. B. Wood.
As Associate Members
V. A. Graves, G. Ramsden.
As Graduates
D. H. Blowers, W. A. Potts.
As Student
V. B. Tucker.
Transfers
From Graduate to Associate Member
J. Speak.
From Students to Graduates
T. B. Smith, F. Whitaker.

NO SECTION
As Graduates
E. G. M. Hasbani, T. R. Russell, M. M. Sadek, T. R. Triantafyllou.

EXTRACTS FROM REGIONAL & SECTION REPORTS

Presented to Council, 26th January, 1956.

EAST & WEST RIDINGS REGION

Doncaster

During the last quarter the Section has held three lecture meetings, all of which have been well attended and followed in each case by a lively discussion.

The Committee were pleased to note that as a result of his Doncaster lecture, Mr. T. B. Maddison, a member of the Section Committee, has been invited to give his paper "Production Methods in Railway Workshops" to the Southern Section.

The Section continues to enjoy support for their activities from local industry and a steady flow of applications for membership. An interesting lecture programme has been arranged for 1956 including the first lecture of its type in the Doncaster area on the subject "Industrial Applications of Atomic Energy".

Halifax

No Quarterly Report has been submitted by the Halifax Section owing to the illness of the Hon. Secretary, Miss N. E. Bottom.

Halifax Graduate

Two lecture meetings have been held during the quarter. At the last meeting the speaker was Mr. W. F. S. Woodford, Secretary of the Institution.

Thanks to the work of Mr. F. Ainsly, the Works Visit Secretary, two works visits have taken place, one to John Crossley & Sons, carpet manufacturers, Halifax, and the other to the Fountain Glass Works, Leversedge, both of which proved very interesting and were very well attended.

A sub-committee has been formed to organise the 1956 Week-end School, which it is hoped will be held at Ilkley.

The subject to be discussed has not yet been decided.

Plans for the 1956-7 session of lecture meetings have been discussed and the Secretary is already developing a programme.

Sheffield

The Section Committee are pleased that some agreement has been reached by the Education and Membership Committee regarding the Examination structure necessary to implement Council's decision to "Broaden the Base" The Sheffield Section Committee is keenly interested in this subject, particularly in the removal of the bias towards the metal cutting industries, and will welcome changes which make it possible to bring into membership many of the people controlling production in the major industries of the country.

The Committee have also discussed the annual report of their representative on the Research Committee and expressed their pleasure at the excellent work being done. This discussion also gave rise to suggestions for future investigations and active assistance as promised in the form of case studies.

Sheffield Graduate

Following the introduction into the programme of a new type of practical lecture, there are good grounds for satisfaction at the results up to date. One lecture has been held on each of the following subjects :—

"Inspection and Measurement of Screw Threads";
"Automatic Lathes";
"Foundry Practice".

The combined number of applications for these three lectures was 220, which is 60% more than conventional lectures have attracted. Indeed the problem now is "Who can we leave out?", as the number at each lecture has to be limited to 30. Wherever possible, duplicate lectures are being arranged to accommodate more people. After each lecture an inquest is held to highlight the good and bad points with a view to general improvement. Should other Graduate Sections wish to take advantage of the Section's experiences in this venture, the Committee would be most pleased to share their findings with them.

Through a recent enquiry made by this Committee it has been confirmed that a Graduate member can be elected to serve on any Standing Committee except the Finance and General Purposes Committee. Perhaps it will be possible for all the Graduate and Senior Committees to be informed of this fact, as there may be Graduate members of the Institution who are eminently suitable and well placed to assist in various ways.

Yorkshire

The Regional Chairman has requested Section Committees to give consideration to the improvement of the standard of their Reports to Council. The Yorkshire Section Committee have acordingly re-arranged the Agenda of their meetings to give more time to discussion on the matter. Membership applications are now dealt with by a Sub-Committee, and as a result of this re-arrangement there was an opportunity for a very interesting evening's discussion.

The first topic under discussion centred around the more effective operation of local Technical Colleges with which a number of the Committee members are closely connected. It was felt that a greater interest should be taken by Institution members and their firms in the work the Technical Colleges are doing. It is appreciated that the staffing of these Colleges is a difficult problem and that industry may be in a position to help in this matter, should it be called upon to do so. Indeed, it was felt that a Committee on this problem should be set up from local industry to investigate what could be done in this connection. It was suggested that a national effort be made by the Institution to get the support of more firms in the engineering and associated industries to co-operate with the Technical College, and perhaps also the Universities, by providing practical experience facilities for "sandwich course" in industry, although it was realised that such an effort is being made in some areas.

Every endeavour is being made to re-form the Graduate Committee of the Yorkshire Section and junior members were invited to meet the Senior Committee in January.

EASTERN REGION

Eastern Counties

This quarter has seen the start of the Winter programme of lectures, during which the Section Committee again hopes to cover a variety of interests. The first lecture held was a combined meeting in Colchester with the Colchester Engineering Society at which Mr. A. R. Watson gave a paper on "The Application and Manufacture of Ball and Roller Bearings." This meeting was well attended, with about 75 members and visitors present.

The November lecture took the form of the Chairman's Address, when Mr. F. T. Dyer gave a "Brief History of Agricultural Machinery Development and its Manufacturing Problems". The paper dealt with farming implements from the very earliest days up to the combine harvesters and tractor equipment in use at the present time, and went on to deal with some of the problems of design, manufacture and sales experienced today. This meeting was also well attended by members and visitors.

The December lecture was chosen with the Institution's "Broadening of the Base Policy" in mind, and Mr. A. T. Brook gave a paper on "Developments in the Manufacture and Packaging of Granular Compound Fertilizers". The paper gave a survey of the operations involved and then dealt with the handling of the product during the various stages of its manufacture and packaging.

Matters discussed in committee have included applications for membership, the 1956-7 lecture programme, and the possibility of holding Section visits again next Summer, besides other routine matters.

MIDLANDS REGION

Regional Report

With each meeting of the Committee it becomes more apparent that the Regional Organisation is serving a useful function. It is possible to review past activities and accomplishments with satisfaction and to look forward with renewed energy to all that still requires to be done.

The outstanding achievements are that the framework has been built up and is working smoothly ; and that all Sections are operating within their financial budgets — in fact savings will be realised in most cases.

It is anticipated that there will be a freer exchange of ideas between Sections, which will enable the Region to develop further its activities.

Three Regional events have taken place during this session. A lecture meeting was held in December when Mr. F. G. Woollard, M.B.E., spoke on "The Implications of Automation". This proved to be a most attractive meeting with approximately 1,000 tickets issued to those who applied for them.

The Regional Annual Dinner is to be held in April at the Queen's Hotel, Birmingham, and the One-Day Conference will take place at the Longbridge Works of the British Motor Corporation during May, 1956.

Birmingham

This session commenced in September when Mr. R. M. Evans, M.I.Prod.E., Chairman of the Institution's Sub-Committee on Material Utilisation, presented his paper on "Material Utilisation". This was well received and provided substantial grounds for discussion. In October Mr. I. B. C. Robinson, B.A., gave a most interesting and helpful paper on "The Application of Electronics to Industry" ; many members now have a better understanding of the uses and abuses of this kind of apparatus.

The third lecture took the form of a Symposium of Papers on "Practical and Economic Aspects of Modern Metal Finishing" the speakers being Mr. Leyton, Mr. A. F. Brookington and Mr. R. Fyfe. These papers covered a most important part of the field of responsibility of many production engineers and considerable practical help was given by the speakers.

In September the opening social function was an Informal Buffet Dance at the Botanical Gardens. This proved to be a very happy and enjoyable evening.

At a recent Committee meeting Mr. R. C. Fenton's resignation, due to business reasons, was accepted with regret. Mr. Fenton has for the last 25 years been a most valuable and steadfast member of the Section. During this period he has served as Section President for the Session

1939/41, and has also been one of the Section's representatives on the Institution's Council for many years. His wise counsel has been of considerable help in the building up of the Regional Organisation before it became 'official'. All members of the Section hope that Mr. Fenton will continue for many years to participate in our activities.

Arrangements are being completed for a joint film evening with the Engineering Society and the Birmingham Productivity Association.

Birmingham Graduate

Lecture meetings continue to be well attended, but the Committee would like to see more Students and Graduates at these meetings. The film evening held in December was successful when Mr. S. J. Harley, B.Sc., M.I.Mech.E., M.I. Prod.E., gave a talk on his recent World Tour, which included a film. The works visit in November to Boxfoldia Ltd., was successful. This visit gave members in the metal-working industries an insight into one of the lesser known trades of folding carton and box manufacturers.

It is proposed to hold a Graduate Papers Evening in April, 1956. At this meeting, five Papers would be read by Students and Graduates and would be judged by a panel of Senior Committee Members. Awards for the two best Papers would be made on that evening.

Study Groups are to be started by the Graduate Section, this having a two-fold purpose :—

(1) To investigate problems on which there is little or no technical literature available, thus bridging the gap between new processes and methods and existing practices and techniques.

(2) To bring together papers and people, that, at some future date would be presented to the Section as a lecture by one or more authors.

At the Committee meeting held in November, Mr. R. Short was elected Vice-Chairman.

Suggested items for discussion at the Graduate Conference in April, 1956, have been forwarded to the Liverpool Graduate Section.

Coventry

The Annual Dinner and Dance was again a great success and was attended by the Lord Mayor and Lady Mayoress of Coventry, and a number of leading industrialists. For fairly obvious reasons, however, the Committee are forwarding the following resolution to the Regional Committee, as from information received from time to time, it is felt that other Sections may support the resolution as follows:-

> "in view of the publicity value of the Annual Dinner and Dance to the Institution all printing, circularising and publicising expenses should be borne by the Institution."

Wolverhampton

The Section programme for the last quarter has been very successful. Considerable interest has been shown in the lectures and the Committee has been delighted with the increased attendance at the meetings.

The session opened with a paper by Mr. R. A. Rogers, B.Sc., A.M.I.E.E., entitled "Plant Maintenance and Productivity" which was presented to a Joint Senior and Graduate Section Meeting.

Matters relating to automation continue to capture the imagination and interest ; so much so that two November meetings have been held. The Stafford meeting on "Increased Automation of Existing Production Lines" by Mr. J. B. Jay, A.M.I.Mech.E., and the Wolverhampton lecture on "Unit Head Applications" by Mr. C. D. Camwell, both attracted good attendances. At the latter meeting, the excellent Renault film on Unit Head Application was shown.

The outstanding event of the quarter was undoubtedly the Regional Meeting in December at Wolverhampton. Members from all the Sections in the Region together with visitors, made up an excellent attendance and fully appreciated the Paper, "The Implications of Automation" by Mr. F. G. Woollard, M.B.E., M.I.Mech.E., M.I.Prod.E., M.S.A.E.

Wolverhampton Graduate

During this session the Section has been enjoying a very full and interesting programme. Lectures have been held each month. In October a joint meeting was held with the Senior Section when a paper was given by Mr. R. A. Rogers, B.Sc., A.M.I.E.E., on "Plant Maintenance and Productivity". This was very well received, a lively discussion followed and the attendance was good.

In November a film evening was arranged when a film on the Automatic Factory was shown and was very well received. This was followed by three short films on the manufacture of greases, lubricating oils, and cutting oils, which proved to be interesting.

The visits programme has been quite full, a visit being arranged for each month. In October a visit was made to the Universal Grinding Wheel Co. Ltd. This company has been visited on many other occasions and always seems to have something more each time to interest members. In November a visit was made to the company of John Thompson Pressings Ltd., Wolverhampton. Here again the company provided an interesting study. In December a visit was made to a production depot covering industrial and also domestic electrical equipments.

In addition to the Educational side of the programme the Social Committee arranged a Dinner Dance to take place in December. This proved to be as successful as the other functions carried out.

The Comittee have held one full meeting and one social meeting per month during the past three months.

NORTH MIDLANDS REGION

Regional Report

The Committee elected last April to serve on this Region have met twice during the winter session. The first meeting was held in September and the second in December. Both these meetings dealt chiefly with the Regional activities and it was decided at the last meeting that a start should be made to make Preliminary arrangements for a One-Day's Conference next summer. This will be held at Peterborough in June, 1956.

Mr. F. A. Perkins has offered the Region full hospitality for the day. It is hoped that arrangements will be finalised early in the New Year.

The theme for this conference will be "Aspects of Automation".

Leicester

The Section Annual Dinner and the Lecture Programme to date have proved successful.

The Lord Mayor of Leicester, Maj.-Gen. K. C. Appleyard, the Section Chairman, Dr. H. L. Haslegrave, and Dr. Elfed Thomas, the Director of Education, were the Speakers at the Dinner and were very much appreciated.

The January Lecture is to be given by Mr. E. S. Kendall, of the Dunlop Rubber Co., Leicester, as Mr. K. J. B. Wolfe is unable to give his paper as arranged.

Lincoln

During the quarter under review two lecture meetings have been held. The first was held in October, when Messrs. F. Griffiths and H. W. Holbeche read a Paper on the "Design of Transfer Machines under Application to Production". This was a joint meeting with the Newark Engineering Society. In November, Mr. J. Loxham read his Paper on "Control of Quality in Medium Quantity Production". The attendance at both these meetings far exceeded any previous meeting held.

In November, the 3rd Annual Dinner was held and it was a great success. The Section are very much indebted to Head Office for their loyal support.

Nottingham

The new winter session has now opened. Rather unusual subjects have been chosen, but it is considered that they will have a direct influence on production. Whether or not this finds favour with the majority of members will become apparent later in the session.

During November, in addition to a lecture meeting, a visit was arranged to the Nottingham and District Technical College to inspect their large variety of modern textile

machinery. This was particularly interesting, and enjoyed by all members present.

Application for membership and transfer are still being received.

Peterborough

Since the last report the Section has lost the valued services of Committee Member, Mr. E. Cars, who has left to take up a new appointment outside the Section. A founder Committee Member, Mr. H. B. Harris, B.E.M., has been co-opted to the Committee.

Arrangements are now going ahead for this Chairman's Informal Dinner Party. This is a function which has met with considerable success and which has been thoroughly enjoyed by all those present on previous occasions.

Arrangements are also being made for a Conference of the North Midlands Region to be held in Peterborough in June, 1956, on the broad subject of "Automation".

NORTHERN REGION

North Eastern

During the quarter under review the October meeting was well attended when Dr. H. E. North addressed the meeting on the subject "Work Study as Applied to Engineering Operations" and a lively discussion followed.

For the November meeting a diversion was made from the normal production subjects when Mr. A. H. C. Greenwood, A.R.Ae.S., read his Paper entitled "The Development and Achievement of the Vickers Viscount". Following the Paper, Mr. Greenwood presented a sound film illustrating his subject. Although the production of aircraft is almost non-existent in this area, the meeting was very well attended and provided an extremely informative and interesting evening based on a topical subject. The members were appreciative of the distance Mr. Greenwood travelled to present his Paper.

It is recorded with pleasure that the Section Committee is now back to full strength again by virtue of Mr. J. Buck being co-opted to the Committee.

A satisfactory number of applications have been considered by the Membership Sub-Committee and the Social Sub-Committee has been actively engaged organising the Annual Dinner-Dance which is to be held in February.

North Eastern Graduate

The Committee are pleased to note the increase in attendance at the meetings held in October and November. The inaugural meeting of the Session held in October was a Film Evening at which there was shown two films of a standard to be highly recommended, namely "Engineers in Steel" and "Powered Flight". At the November Meeting a Paper was read by Dr. Jagger on the subject of "The Design and Uses of Oil Seals and Packings", which was followed by a visit to the works of Messrs. Geo. Angus & Co. Ltd., Oil Seals Division, Newcastle.

A meeting was held in January when Mr. R. Gabriel read his Paper "Machine Tools — from Wilkinson to Automation".

NORTH WESTERN REGION

Arrangements are now complete for the Regional Dinner which is to be held at the Midland Hotel, Manchester, in February.

The Regional lecture is to be held in April at the Manchester College of Technology, and Sir George Barnett of the Factory Department of the Ministry of Labour is to give a Paper entitled "The Factory Acts and How They Affect Engineering Establishments".

Arrangements have now been made to hold a golf competition between the Sections of the North Western Region at Shore-hill Golf Club, Chorley. The game will be followed by a dinner and presentation of the golf trophy.

The Manchester College of Science and Technology has now been granted a Royal Charter and Mr. Cranmer, Chairman of the North Western Region, is to represent the Institution on tht Board of Governors.

Liverpool

The Committee meeting in December held a special discussion on the overlapping of other Institution's memberships with our own. As the policy of broadening the base created a similar situation it was felt that little could be done at the moment to avoid or curtail "poaching" and duplication of effort.

The Warrington and District Productivity Committee, which is very active, are circularising all firms in Warrington, Widnes, Runcorn and Leigh, with a view to their occupying a stand at the Production Exhibition and Conference in May at Olympia. It is intended that the Stand will show in some form, increase in productivity.

Liverpool Graduate

In November, Mr. M. H. P. LeVie gave a most interesting lecture on "Some Large Applications of Aluminium Alloys". Many slides and short films were shown.

The Section visit to Messrs. Arthur H. Lee, tapestry manufacturers at Birkenhead, proved to be most instructive and many interesting items of plant and management principles were noted with satisfaction.

The Hazleton Memorial Library Panel has once again commenced its work of reviewing books from the Institution's Library.

It has been decided that the theme for the Graduates' Conference shall be "Education for Automation" and that the Conference will be a National Conference for Junior Members of the Institution. It is hoped that two Graduate members and two Educationalists will deliver Papers. Mr. S. A. J. Parsons and Mr. K. J. Hume have accepted invitations to speak as educationalists. A private session at which representatives of Graduate Sections will discuss matters of mutual interest will also be held. Several local firms have already given very generous financial support.

Manchester

The second lecture meeting of the session held in October was a Paper given by Mr. M. Short, B.Sc.(Eng.), entitled "Cutting Tools — Application and Research". This was well illustrated by slides, and was followed by a practical and interesting discussion. The Manchester Section strongly recommend this Paper to all Sections.

The third lecture entitled "Diesel-Electric Traction" was given by Mr. E. T. Bostock, B.Sc.(Eng.), A.M.I.E.E. Illustrations were by slides and covered all aspects of this form of traction. The Paper was followed by a lengthy discussion, which included the problems of modernising the British Railways.

The Ladies' Evening in October was a most successful event. The Committee are looking forward to a further function on the same lines. Arrangements for the Regional Dinner to be held in February, in Manchester, are now complete.

The Manchester Section Committee wish to put on record their thanks to Mr. J. P. Speakman, for taking over successfully the offices of Honorary Secretary of the Manchester Section and North Western Region. Mr. F. W. Cranmer, a member of the Manchester Section Committee now represents the Institution on Committees of the following Colleges: The U.L.C.I.; The Royal Technical College of Salford; Manchester College of Science and Technology; Bury Technical College.

Preston

The first half of the winter programme has now been completed and comprised three lectures, all of which were reasonably well attended. The December lecture was held in the Lecture Hall of the Accrington College of Further Education which was placed at the Section's disposal by the Head of the College, Mr. S. R. B. Swan. All the members and visitors who attended the lecture took the opportunity of visiting the Workshops, Metrology Laboratory and Classrooms of the College, and were very much impressed with the facilities for the teaching of Production Engineering. The lecture given by Mr. H. Bayley, B.A., on "Reading Techniques" was interesting and instructive, focussing attention on the great variation of the reading between different individuals. The lecture was followed by an interesting discussion.

At the December meeting of the Section Committee it was decided that a Social Evening should be arranged to take place in March at Salmesbury Hall, near Preston. This will be on similar lines to the one held in 1955 and it is hoped that it will be equally well patronised. Mr. F.

Grimshaw, Vice-Chairman of the Preston Section is still in India on business, but expects to be back in England early in the New Year.

Stoke-on-Trent

Two Committee meetings were held during the quarter, both of which were well attended. Considerable discussion has taken place at the Committee meetings on the future strength and composition of the Committee in order that the Section shall be assured of a strong and workmanlike body of officers.

The first lecture meeting was held in October. The lecture was given by Mr. W .R. Bailey, a Graduate member of the Stoke-on-Trent Section, and was entitled "Some Interesting details to the Engineer obtained during my recent visit to Germany". Mr. Bailey was last year's winner of the Schofield Travel Scholarship. The lecture was exceedingly well received and invoked a lively discussion.

The second lecture meeting was held in November when a lecture on "The Shell Moulding Process" was given by Mr. D. N. Buttrey, of I.C.I. Ltd. The Paper was exceptionally well given and received, and a measure of its success may be taken from the fact that a closure on questions was necessary after three-quarters of an hour. The meeting was also well attended.

The Section Chairman, Mr. Porter, and two other members of the Section Committee, Mr. Hayek and Mr. Petrie, are actively supporting the Local Productivity Council. The Council has recently commenced its second series of circuit visits, with sixteen factories participating.

SCOTTISH REGION

Dundee

Attendance at last year's lecture meetings has been very satisfactory, in spite of the many difficulties of a large area with a scattered membership. One of these difficulties can best be appreciated by the fact that a new member would have to travel 220 miles to attend one of the meetings. So far there are no members in Orkney or Shetland.

The first meeting held during the quarter was a joint discussion with the Institute of Industrial Administration on "The Impact of the Automatic Age". The discussion was both wide and varied. The consensus of opinion was that automation would spread first through the process industries, but there would be no impact on general engineering, in fact for many of the smaller firms, all it would amount to would be improved method study.

The second meeting was a lecture by Mr. H. J. Watson on "Modern Gear Production". This lecture aroused a lively interest in the area, and this was evident by the keen discussion which followed. Mr. Watson's knowledge of gear production is profound, and his answers to the many questions were inspired with the quiet confidence of years of experience.

The Section Committee is very fortunate to have the use of the Technical College Board Room for their meetings and their thanks are due to the College authorities for this privilege.

The number of students attending Production Engineering classes at the Technical College is increasing, but the position in this area would rapidly improve if employers would encourage students whose future lies in Production Engineering to specialise.

SOUTHERN REGION

Oxford

Mr. E. A. Wootton has now taken over as Honorary Secretary of the Section, folowing the resignation of Mr. M. J. Inston.

Two lecture meetings were held in October. The first was entitled "Automatic Transfer Mechanisms" and was presented by F. Griffiths and H. N. Holbeche. The various transfer machine elements were discussed and lantern slides were used profusely to illustrate the more complex details.

The second October meeting was very well supported by local engineers, over 100 being present. Mr. D. A. Ellis presented a Paper entitled "Automation in the Aluminium Industry" and also the colour film "The Kitimat Story" depicting the construction of the gigantic hydro-electric and smelter project in British Columbia.

The November lecture meeting was held at the R.E.M.E. Garrison, Bicester. A series of films on the various uses of petroleum was followed by a Question Forum, the Oxford Branch of Shell-Mex and B.P. Ltd., providing a panel of experts who promoted a most lively discussion. Although this programme was arranged as a substitute on the spur of the moment it proved such a success that it is intended to hold a repeat in Oxford.

In December, Mr. S. A. J. Parsons, Principal of Wellingborough Technical College, gave an excellent review of the academic requirements and opportunities afforded to embryo engineers. Several members of the teaching staff of local Technical Colleges were present and the exchange of their opinions with those of the lecturer made for a most entertaining evening.

SOUTH EASTERN REGION

London

The three lecture meetings held so far have been well supported. A particularly successful meeting was held in December entitled "Unusual Aspects of Modern Press Work"; this meeting was in the form of a symposium of three short Papers followed by a discussion. By this means a wide coverage of the subject was obtained without the necessity of finding a single speaker prepared to do the amount of preparatory work necessary for a full lecture.

Arrangements have now been made for the vacant dates on the lecture programme as follows. In January a lecture will be given on "Marginal Costing" and in February a Film Evening has been arranged to be held in Brighton. The March lecture will be on the subject of "Computors".

Luton

The Section is experiencing a successful period as regards its lecture programme. All lectures have been well prepared and the level of attendance shows a marked improvement.

A recent Committee meeting dealt with the planning of next year's programme, which will be built around a central theme.

Co-operation with other professional bodies is being maintained, and especially the Institution of Mechanical Engineers (Eastern Branch). It is now a well-established practice for a joint lecture meeting to be held on a reciprocal basis each year.

A special effort is to be made for the Section to present an original Paper worthy of publication during 1956/57 and arrangements are being made accordingly.

South Essex

The first three meetings of the winter programme have now been held and were in all ways successful. At the opening meeting in October at Chelmsford, Mr. G. S. Bosworth presented a Paper entitled "Training of Production Managers and Engineers" to a well-attended meeting. The Paper on "Powder Metallurgy" by Mr. G. R. Bell, was also well received at Ilford in November, and Mr. J. Lees' Paper on "Production Control" given at Chelmsford also in November provoked a very lively discussion. The Papers by Mr. Bosworth and Mr. Lees were both originals and the three meetings averaged an attendance of over 60 members and visitors.

It is anticipated that the remaining four meetings of the present session will be as interesting and as well attended.

Rochester

The Committee have been very much alive to the desirability of having a Graduate Section centred in Rochester to cater for the training and encouragement of the younger Production Engineer. A lot of work has been put into this project and it will culminate in a meeting of the Graduate members of the Section in January. At this meeting it is hoped to move the project into a position where the Senior Committee can apply to Council for sanction to form this Graduate Section.

SOUTH WESTERN REGION

Cornwall

A lecture meeting in November at the Camborne School of Mines was very well attended and the Committee have every reason to feel satisfied with the efforts to promote more interest and increase attendance.

"Glass Manufacture" was the title of a joint Paper by Messrs. G. McM. Brown and J. W. Webber of the

Bristol Branch of Pilkington Bros. Ltd. It was well illustrated by sound films and other amazing and amusing demonstrations on the physical properties of glass.

A lively discussion followed and many members and visitors were of the opinion that they had enjoyed the best evening ever with the Production Engineers.

The necessary ground work and planning has started in connection with the second "Compressed Air Conference" to be held in Camborne at Easter, 1957, under the auspices of the Section.

Gloucester

In October the winter programme opened with a lecture entitled "The Future of Aircraft Production" by Mr. S. P. Woodley. A film illustrating various types of routine machines and methods employed in skin milling of airframe structures. Many models and test-pieces were on show. This lecture was of great interest to members locally, there being a considerable amount of aircraft work carried out in this area.

In November, Dr. D. F. Galloway delivered his lecture "The Practical Application of Production Engineering Research" in Cheltenham. The lecture, which was illustrated by a film, was of great interest to those present.

In December an exceptionally good lecture was given by Mr. D. Jones, B.Sc., (Hons. on "Induction Heating"). The lecture, which was informative, was well attended. Mr. Jones treated this difficult subject well and illustrated the many uses of induction heating, giving an insight into its wide future. The meeting was followed by a visit to the Research Laboratory of Messrs. Delapena's, when members were able to see many of the applications in action.

It is suggested that the Sections who have not followed up their lectures with Works Visits, appertaining to the lecture, will find them beneficial, and should endeavour to arrange these.

WELSH REGION

West Wales

Lectures on the "Still More for Less" theme have interested members and others during the quarter and by their scope invited interest over a very much extended field. Activities have also included a visit to the factory of Messrs. Geo. Kent at Resolven. The variety and extent of the company's products interested many members who had not previously realised the contribution made to other branches of industry. Notable in this respect was the production of motor car steering gear. Following the tour of the factory, Section members were entertained to tea by the Directors, represented by Capt. V. J. Sankey.

A Social Sub-Committee is completing its arrangements for a social event to be held early in the New Year.

In view of the continued interest and concern of the Committee in the matter, a Sub-Committee has been formed to examine technical education locally in connection with those aspects which specifically apply to production subjects and training. They will examine curricula from the various educational establishments and report to the Committee with a view to making recommendations which may appear desirable.

SECTIONS OUTSIDE THE U.K.

Adelaide

At the September meeting, Mr. W. I. Miskoe presented a lecture on "Incentives". He ably described job evaluation, payment for the job, and for increased skill.

At the Annual General Meeting, Mr. C. J. Clark, M.I. Prod.E., was re-elected Section Chairman. In his address Mr. Clark described the progress of the Section since the formation five years ago, and referred to plans for the future. Films showing the use of Hueller and Renault heads on automatic transfer machines closed the evening.

A lecture on "Recent Developments in Resistance Welding" by Mr. D. H. Lindsay, A.M.I.E.(Aust.) was given in November.

The Education Sub-Committee has prepared a report on the Section's views on Broadening the Base, and has examined the Production Engineering of the Perth Technical College Course with a view to submitting this to the London Education Committee for granting exemption.

In co-operation with the Institute of Management, Institute of Accountants and Institution of Engineers (Aust.) a Conference was held on "Raising the Efficiency ot the Office". This was a two-day function in which nine papers were presented.

The Australian Council meeting was held in Adelaide in November, and the Committee entertained Council members at luncheon, and at the November general meeting.

Melbourne

The Melbourne Section held its annual meeting in October, when 77 members attended. Mr. C. Pullen, M.I. Prod.E., was elected Chairman and Mr. E. J. Herbert, M.I.Prod.E., Vice Chairman. Committee members who were due for retirement were re-elected.

After the Annual Meeting a paper entitled "Screw Thread Production by Modern Methods" was presented by Mr. J. S. Murphy, A.M.I.Prod.E.

The Section Annual Dinner was held in November at Union House, University of Melbourne. The Guest Speaker for the evening was the Hon. A. G. Warner, Minister of Transport and Chairman of Directors of Electronic Industries Ltd. Mr. Warner spoke on "The Productivity of Decision." The dinner was most successful and thoroughly enjoyed by the 140 members and friends present.

Sydney

Further to the address given in May by Mr. A. F. Pain of the Sydney Water Board, a most interesting day was spent visiting the Warragamba Dam, which is to supply Sydney in the future with most of its water. This Dam is being constructed by the Water Board.

The Annual General Meeting took place in October and the Section Officers for the next session were elected, Mr. J. Ogden being re-elected President. Mr. R. C. Long then gave a paper on "Air Gauging", very suitably illustrated by films.

The Dinner held in November was again a great success and 125 members and friends attended. The Guest of Honour, Mr. R. J. F. Boyer, Chairman of the Australian Broadcasting Commission, gave a very enlightening address on the "Effect of Television". Mr. J. N. Kirby, the Australian President, gave a toast to the guests, to which Mr. D. W. Scott responded.

The last Committee meeting for the year was held in December and was well attended.

South Africa *(General Meetings)*

In October, Mr. Norman Fleming, B.Sc.(Eng.), A.M.I. C.E., Honorary Consultant, Anglo-American Council on Productivity, delivered a paper on "The Engineer and Productivity". The paper stimulated wide interest and was followed by lively discussion.

A new field of production engineering was introduced to the Institution by Mr. A. F. Cole, A.C.I.(S.A.), I.E.E., when he spoke on "Production Engineering in the Clothing Industry" in November. Mr. Cole very successfully handled the meeting by permitting questions to be put as the lecture progressed.

The Institution of Mechanical Engineers invited members of this Institution to take part in the paper on "The Role of Modern Management Methods in the Economic Development of South Africa" presented by Mr. C. E. Bedaux iin November.

Mr. J. Woolfson, the holder of the S.A. Branch's 1954/55 Papers Award, presented his talk on "Techniques of Improveing the Selection of Staff" in December. The paper was supplemented by several examples of the various forms used in this regard and the members present became acquainted with many interesting facts.

Visits

On the evening of 22nd November, members of the Institution were afforded the opportunity of visiting the works of Messrs. National Bolts and Rivets Ltd., in Boksburg North, Transvaal. The visit was of great interest to the many members present.

Section President

During the past weeks the President of the South Africa Section, Mr. H. J. G. Goyns, visited the United Kingdom and Europe. Mr. Goyns paid a visit to the Head Office of the Institution and was afforded the opportunity of discussing some of the many problems which the South Africa Section encounters.

The Wolverhampton Section Dinner-Dance held at the Mount Hotel, Tettenhall Wood, on 23rd December last, was a most successful and enjoyable occasion, as is evident from this photograph

BELOW

In this group, photographed at the Coventry Section Dinner-Dance on 14th October, 1955, are *(left to right)* The Lord Mayor of Coventry ; The Mayor of Rugby ; Mrs. W. G. Rootes ; Mrs. S. J. Harley ; Mr. W. G. Rootes (Coventry Section Chairman) ; Mr. S. J. Harley ; The Lady Mayoress of Coventry ; Mrs. Clarke ; The Mayoress of Rugby ; Mr. G. R. Pryor (Chairman of Council) ; and Mr. Clarke.

news of members

Mr. Harold F. Beaumont, Member, Works Manager of The Parkinson Stove Co. Ltd., has been appointed a Director of the Company.

Mr. L. E. Broome, Member, has been appointed a Justice of the Peace for Cheltenham.

Mr. E. H. Y. Burden, Member, who was until recently a Director of Machine Tools (India) Limited, Bombay, has been appointed Machine Tool Advisor to The Plessey Development Company. Mr. Burden was for some years Honorary Secretary of the Bombay Section.

Mr. R. M. Evans, Member, has been appointed Assistant Managing Director of the Imperial Typewriter Co. Ltd. Mr. Evans was previously Works Director. He is also a Corresponding Member of the Institution's Papers Committee.

Mr. N. N. Sen Gupta, Member, who was the Honorary Secretary of the Calcutta Section from 1954 until 1955 and Honorary Treasurer from 1955 until January, 1956, has been appointed Director of Training, Ministry of Labour, Government of India, New Delhi.

Mr. H. L. Logan, Member, who was Production Manager with Blaw-Knox Limited, Watford, is now Chief Production Engineer with Cox & Co. (Watford) Limited.

Mr. J. Milwain, Member, who was employed by David Brown & Sons Limited, Huddersfield, for nearly 30 years in the capacity of Chief Inspector and Chief Works Superintendent in the heavy and light engineering divisions, has been out in South Africa with David Brown Precision Equipment (Pty.) Ltd., Transvaal, in a technical capacity and also as Production Engineer. Mr. Milwain is now returning to England.

Mr. T. G. Quinney, Member, has at his own request been released from the Board of Messrs. Drummond-Asquith (Sales) Limited, Birmingham, to take up an appointment as Managing Director of Messrs. A.M.T. (Birmingham) Ltd., Birmingham.

Mr. H. F. Spinks, Member, has resigned from the Sentinel Company, Shrewsbury, and has joined Messrs. Platt Bros. & Co. Ltd., Oldham, as Methods Engineer.

Mr. H. Unsworth, Member, has been appointed Works Director of The Lockheed Hydraulic Brake Co. Ltd., Leamington Spa. He was previously General Works Manager. Mr. Unsworth serves on the Institution's Materials Handling Sub-Committee.

Mr. J. Wombwell, M.B.E., Member, who was Works Manager of the Imperial Typewriter Co. Ltd., has now been appointed Director and Works Manager.

Mr. R. W. Austin, Associate Member, has now taken up an appointment as Lecturer in Management Studies at The Central College of Technology, Northampton.

Mr. A. J. Bullivant, Associate Member, has now been appointed to the Board of Directors of Lamson Engineering Co. Ltd., London.

Mr. E. Cars, Associate Member, has recently resigned his position with Messrs. F. Perkins, Peterborough, to take up an appointment as Works Manager with the Turner Manufacturing Co. Ltd., Wolverhampton. Mr. Cars was also a member of the Peterborough Section Committee.

Mr. G. W. Cole, Associate Member, has relinquished his position with Triplex Safety Glass Co.

Mr. R. B. Dann, Associate Member, has terminated his appointment with The Newall Engineering Co. Ltd., Peterborough, and has taken up an appointment with Associated Industrial Consultants Limited, London.

Mr. E. R. Eccles, Associate Member, has left the Halifax Municipal Technical College and is now a Lecturer in Mechanical Engineering at the Leeds College of Technology.

Mr. D. J. I. Gray, Associate Member, has relinquished his appointment with Messrs. Booth, MacDonald & Co. Ltd., of Christchurch, New Zealand, where he was Production Controller. He has now taken up a position as Works Manager of the Letchworth factory of Messrs. Cooper Stewart Engineering Co. Ltd., of Letchworth, Herts.

Mr. T. L. Isaacs, Associate Member, has resigned his position with The Glacier Metal Company Limited, Kilmarnock, and has taken up an appointment as Production Manager with the National Switch Factories, Keighley and Liverpool.

Mr. J. G. Lloyd, Associate Member, has been appointed Managing Director of George Mann & Company Limited, Leeds, a subsidiary of Vickers, Limited.

Mr. A. Marsden, Associate Member, is now Chief Tool Designer with Messrs. Woodside Die-Sinking Co. Ltd., Horsforth, near Leeds.

Mr. L. P. Simpson, Associate Member, has been appointed Works Manager of Baker Perkins Limited, Peterborough. Prior to this appointment he held the position of Production Manager with the same Company. Mr. Simpson is a member of the Peterborough Section Committee.

Mr. G. W. Stokes, Associate Member, has left the Guest, Keen & Nettlefolds organisation to take up a position as Work Study Officer, with the General Chemicals Division of Imperial Chemical Industries, Limited.

Mr. R. A. G. Welsher, Associate Member, has recently been promoted to Engineer II and will be taking charge of the Remote Handling Group at Harwell.

Mr. B. Whittaker, Associate Member, has left the County Technical College, where he was Senior Lecturer in Engineering, to take up a position with Industrial Administration (R & A) Limited, Management Consultants, London.

Mr. H. Yates, Associate Member, announces that he is no longer associated with Surrey Tool Development Co. Ltd., and Dyne Engineers Company.

Mr. M. E. Clark, Graduate, is now at the Inter-Services Research Group, at Waltham Abbey, Essex, and is a Production Engineer responsible for liaison between scientists and manufacturers, on prototype and medium quantity production and inspection.

Mr. G. A. Felton, Graduate, has relinquished his position with the Ministry of Works, Engineering Division, and is now employed as an Engineer in the Atomic Power Department of the English Electric Co. Ltd., Leicester.

Mr. H. G. Jones, Graduate, has now been appointed Sales Engineer to cover Scotland and Northern Ireland for his Company, Sidney G. Jones Limited.

Mr. J. D. Parson, Graduate, has relinquished his position with Fortiphones and has now joined the Solartron Engineering Company, Limited, of Thames Ditton, as their Senior Methods Engineer.

Mr. K. R. Snowden, Graduate, has now joined W. T. Henley's Telegraph Works Co. Ltd., at their Gravesend Works, as a Graduate Trainee studying cable technology.

Mr. G. V. Shaw, Graduate, has been transferred from I.C.I. Metals Division, Kirkby Works, to Fyffe Works, Caroline Port, Dundee, as Deputy Manager.

Mr. A. M. Stewart, Graduate, is now employed as Liaison between Saunders-Roe, Production Engineering department at Cowes, and their works at Eastleigh.

Mr. K. F. Watson, Graduate, has relinquished his position with The English Electric Company to take up an appointment with Morris Motors Limited, Oxford, as a Planning Engineer in their K.D. Division.

Mr. K. S. Worthington, Graduate, has taken up a position as Inspector of Mechanical Engineering Mines and Quarries, under the Ministry of Fuel and Power, South Western Division.

THE LORD AUSTIN PRIZE

AMONG the awards offered annually for competition among members of the Institution is the Lord Austin Prize. Its founder, the late Lord Austin, who was President of the Institution from 1931 to 1933, gave £100 for the foundation of the Prize and this sum was subsequently considerably augmented by the Austin Motor Company, Limited ; the value of the Prize for the year 1955/56 will be £17 10s. 0d.

The Prize may be utilised to defray all or part of the cost of attendance at a conference, summer school or short course which will assist the recipient to further his career in production engineering. The prizewinner is free to decide how to utilise his Prize subject only to approval of his project by the Institution. Advice and guidance on this point will be willingly given on application to the Institution.

A Certificate is also presented as a permanent memento of the Award.

Essays submitted for the Prize are assessed under the following headings :-

Evidence given of the importance of the subject to production ;
Content (technical/managerial) ;
Planning (logical development of the subject) ;
Style ;
References, illustrations, charts, graphs, etc.

Apart from the monetary value of the Prize, success in a competition of this nature is a marked achievement which could well be of considerable assistance to a young man in his future career.

The conditions for the 1955/56 Award are :-

1. All Graduates of the Institution under the age of 30 years may compete.
2. Essays may be submitted on any subject within the field of production engineering. Before candidates begin preparing their essays, titles and brief synopses must be sent for approval to the Secretary of the Institution, to reach him not later than 1st May, 1956.
3. Essays should be not less than 2,000 nor more than 4,000 words in length.
4. Completed essays must be submitted by 1st July, 1956, and should be sent to : The Secretary, Institution of Production Engineers, 10 Chesterfield Street, London, W.1.

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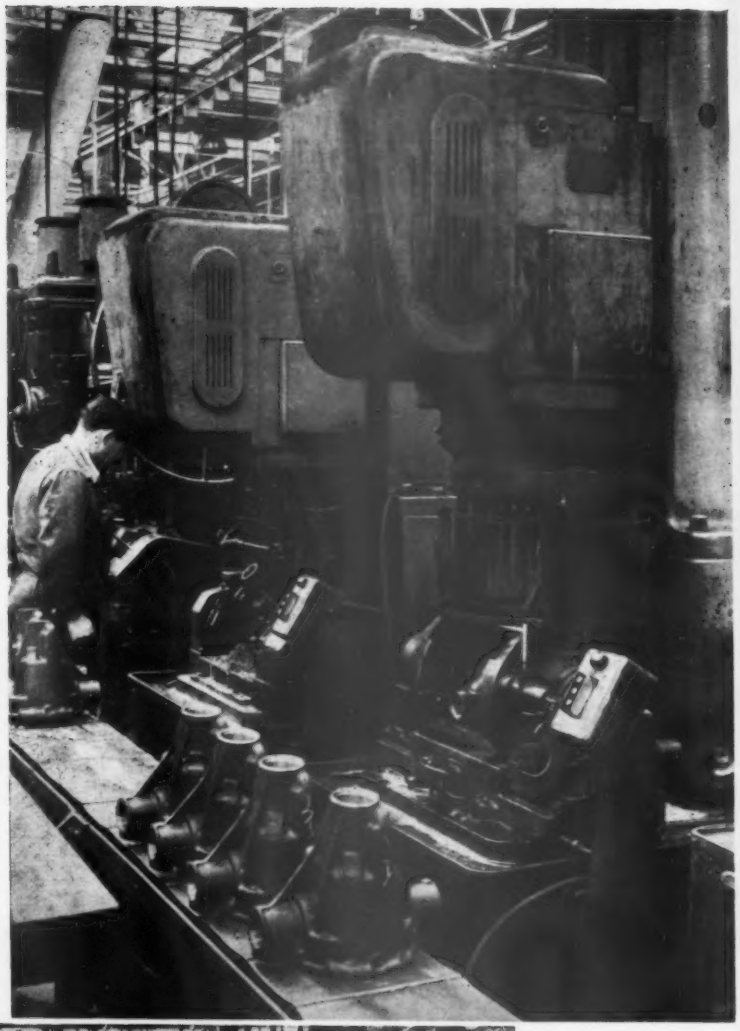

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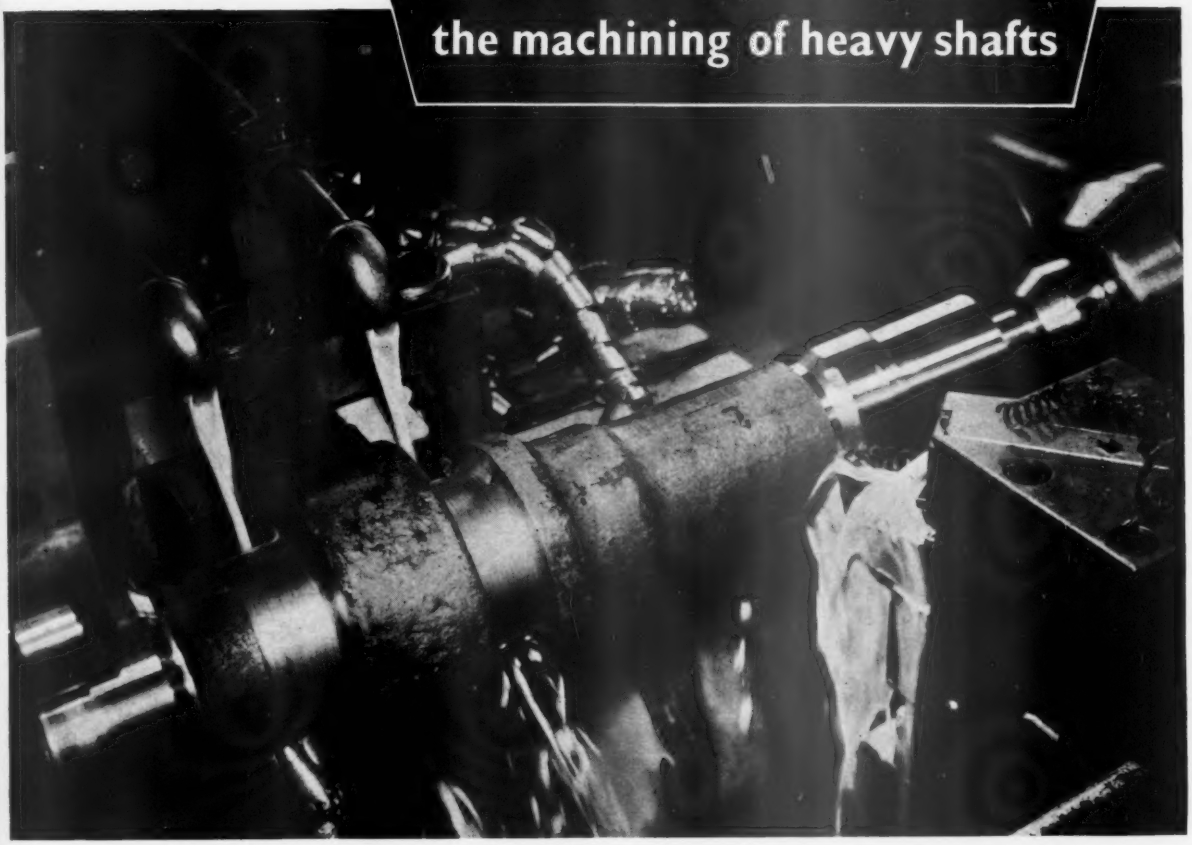

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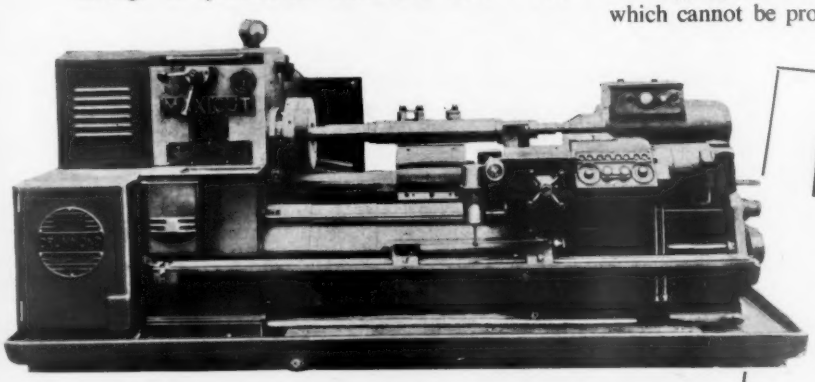

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COPYING LATHE

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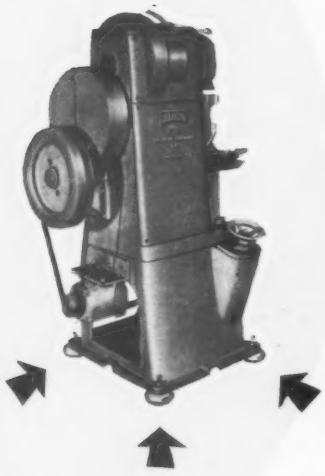
Make your machine line MOBILE



★ **STEP UP production**

★ **REDUCE costs**

★ **Machinery that moves with the times increases output**

★ **Production lines can usually be improved**

★ **Idle machines standing bolted to the floor are wasting space**

By fitting the machines with Barrymount levelling mounts, a whole production line can be re-arranged to improve the flow of work, in a matter of minutes instead of hours . . . or days. **Plant mobility can increase output and lower production costs.**

Barrymount levelling machine mounts practically eliminate vibration. They do away with the old method of bolting machinery to the floor or to concrete foundations. Yet the **machines will not "walk."** External shocks and vibration are isolated, cutting down spoilage in precision machining. Noise from heavy and high-speed plant is reduced to a minimum : this means higher worker efficiency.

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BARRY B MOUNT LEVELLING MACHINE MOUNTS

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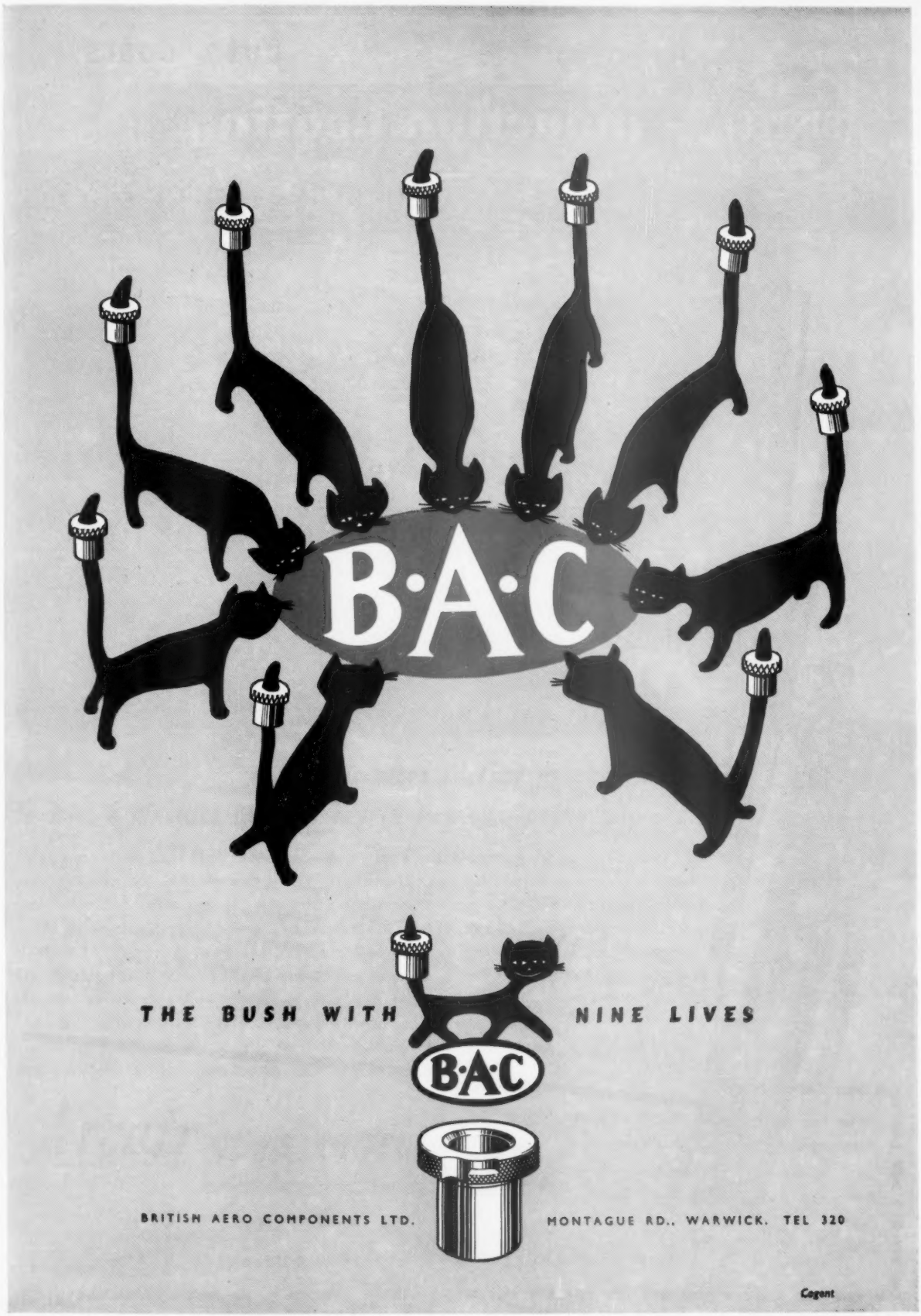
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cuts costs

induction heating

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☆ The BIRLEC induction surface hardening machine illustrated here is a standard unit capable of handling a range of varied jobs. It is widely used by the automobile industry for the selective treatment of rocker shafts, selector rods and similar components.

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Specified zones can be hardened under automatic control and with negligible distortion or scaling of the work. Quickly interchangeable, standardised control cams and inductors permit several different jobs to be run economically in successive batches.

Illustrated are typical induction hardened automobile rocker shafts and selector rod.

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Maximum diameter of work ...	1½"
Hardening zone selection	Cam
Maximum hardening speed ...	1½"/sec.
Maximum return stroke speed ...	6"/sec.
Typical production (12" stroke) ...	300/hr.
Typical operating cost ...	0.17d/piece.

Please send me Publication No. 78 on Shaft Hardening or further process details about

.....

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..... VSHM

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(PATENTED)

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Fabrication of the REACTOR, part of the new HYDROFORMER unit being built by FOSTER WHEELER LTD. for the ESSO PETROLEUM CO., LTD. The ARCAIR Torch is being used to back-gouge the outside welds, prior to welding the inside seams. The shell plates of this vessel are 2¼" thick. Construction must meet the stringent requirements of the A.P.I.A.S.M.E. code and is subject to 100% X-Ray inspection. Lincoln machines and Fleetweld 5 electrodes are being used throughout. ***The Arcair Torch*** saves on cutting and gouging up to 80%! This new patent complete unit uses only electric arc and compressed air. Air-cooled for operating-comfort, with self-aligning rotating jet for adjusting carbons to all angles. Melts *any* metal by electric arc, then dissipates the molten metal by continuous high-velocity compressed air. Special Arcair copper-coated graphite carbons, in 7 sizes, are used.

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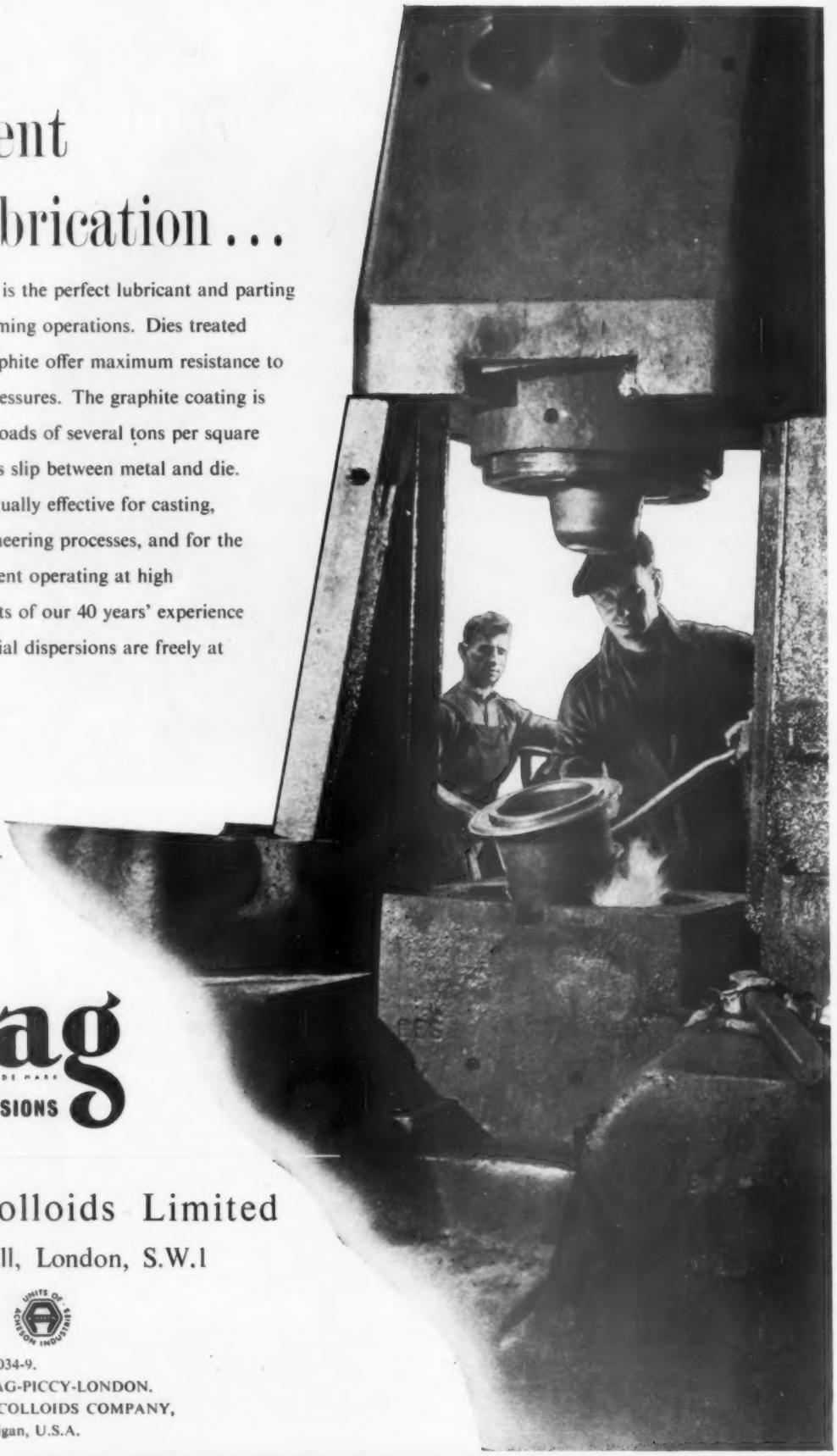

A Dome forging being extracted from a die lubricated with "dag" colloidal graphite.

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Progressive manufacturers acknowledge the superiority of coated abrasives by CARBORUNDUM. They have turned to products by CARBORUNDUM for grinding and polishing in preference to set-up wheels and dressed mops.

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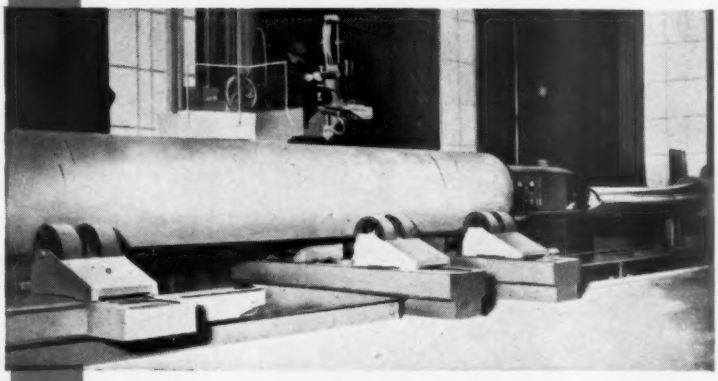

External and internal welding of Class 1 boiler drums, by the Fusarc process. Note the versatile cantilever—supported automatic welding head; boom-type internal welder (right) with effective welding traverse of 15′ 0″; and the adjustable motorised roller bed, working in conjunction with an idler-bed unit. All manufactured, installed and serviced by Quasi-Arc Limited—and only one of many complex automatic welding installations now in production.

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Quasi-Arc are the only people who make and sell *two* continuous automatic arc welding processes—Fusarc and Unionmelt, with all their present-day variations.

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The biggest-selling continuous covered electrode process in the world—and in its field the most economical. Fusarc with its visible arc, runs fast and efficiently, and gives excellent results both indoors and outdoors.

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The interests and activities of The Quasi-Arc Company Limited and Fusarc Limited in the well-known processes

Quasi-Arc · Fusarc · Unionmelt · Sigma · Heliarc · Twin-Arc

have been combined in order to provide a thoroughly comprehensive and effective service to the welding industry.
The headquarters of the new organisation—named Quasi-Arc Limited—are at Bilston, Staffordshire, with works at Bilston and Gateshead.

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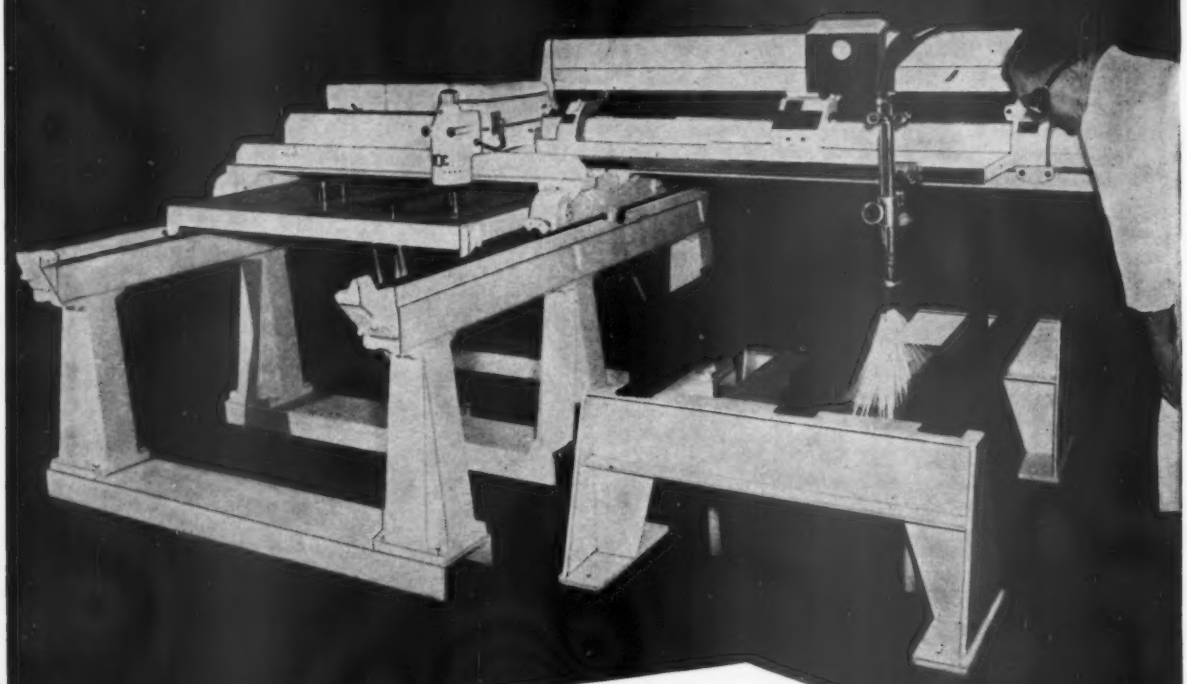
The Torch of Industry



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(4) UP TO THREE CUTTERS — Can be mounted on the boom for multiple cutting.

(5) USES ALL FUEL GASES — The BISON will operate on Acetylene, Propane or Coal Gas.

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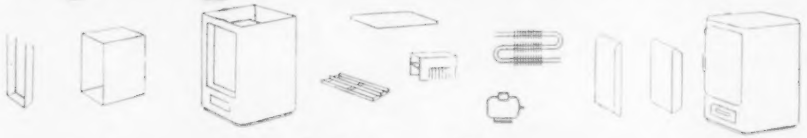
*Do you put bottles in crates?**



or assemble refrigerators?*

or furniture?*

or make a lot of motor cars?*

* *Just a few of the very many MAXAM applications*

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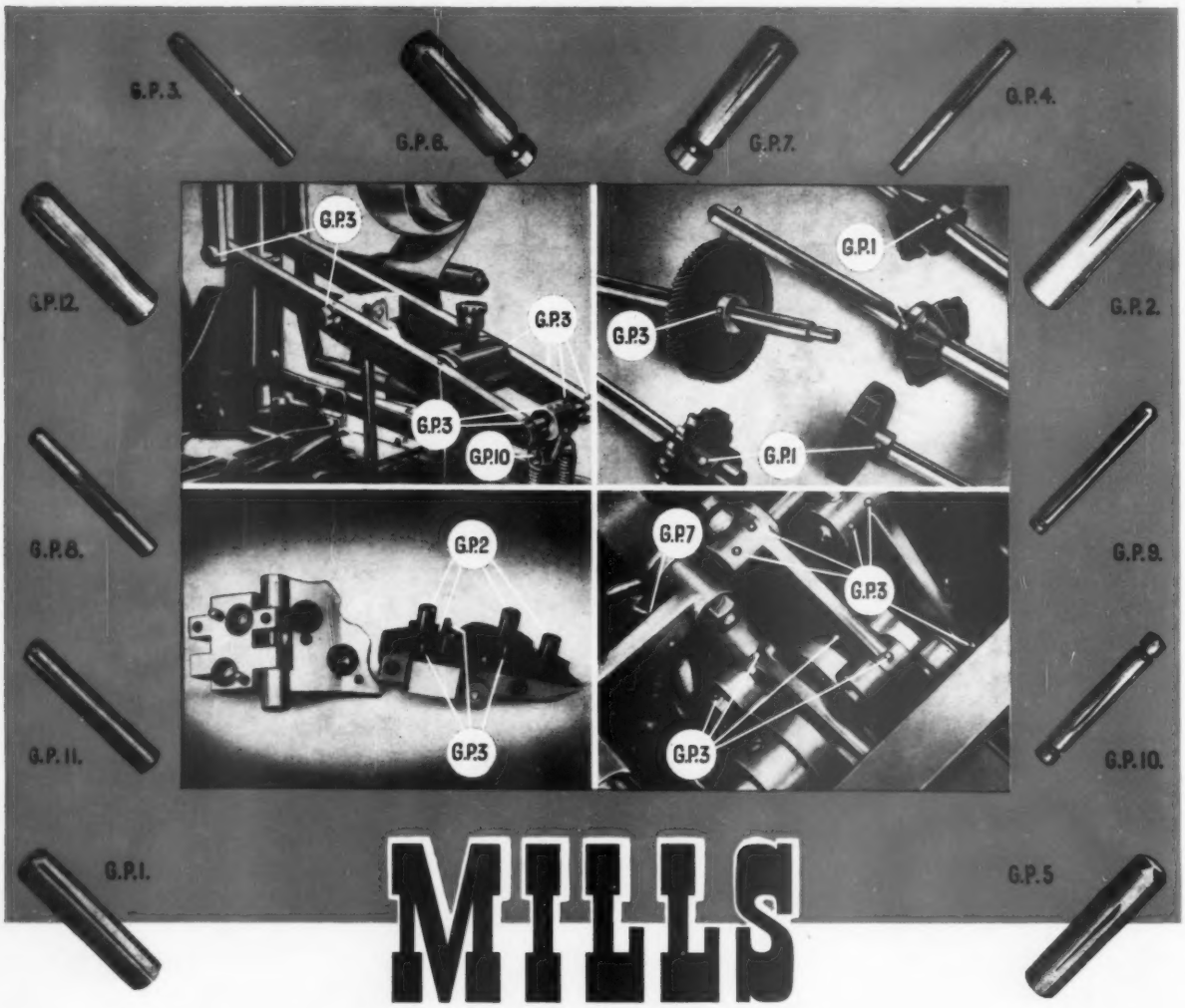

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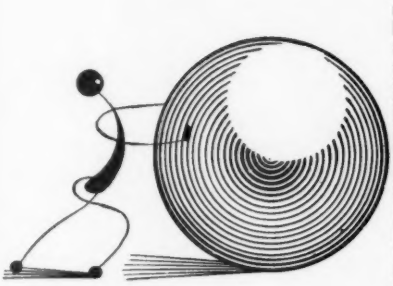
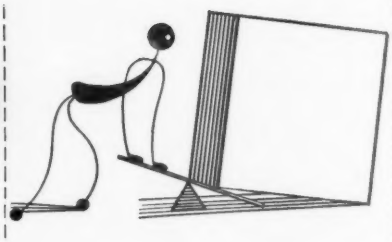
Hymatic Automation

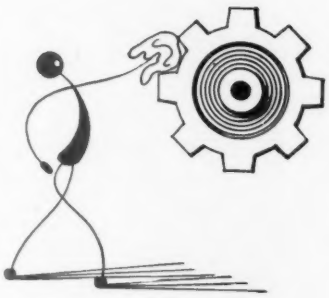
IS THE NAME FOR MACHINES THAT



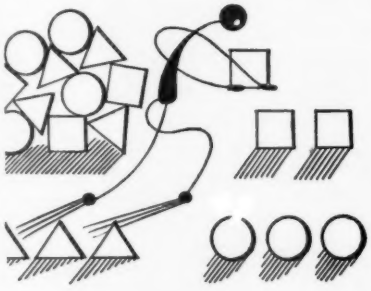
...roll...



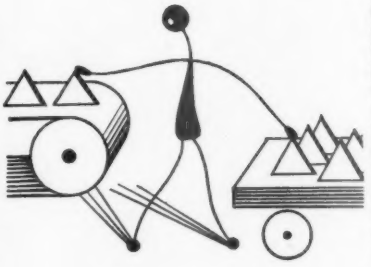
...dislodge...



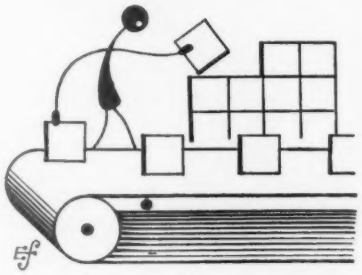
...clean...



...sort...



...shelve...



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. . . reach, grasp, carry, lift, turn, clamp and tilt. Hymatic Automation is thus invaluable in the automatic and selective transfer of parts from one process to the next, from conveyor to conveyor; in unloading one machine and loading the next; or in quick clamping to hold parts during machining. All designs of Hymatic Automation are made for specific tasks but are readily adaptable to others.

Hymatic Automation covers the whole problem—the design of the circuit—the machine—the means of control.

Hymatic Automation, therefore, has a place in your programme of productivity improvement.

Perhaps in your Works, too, there are jobs where it is possible for people to burn or cut themselves, strain or crush themselves, lose fingers or even a hand; or perhaps there are jobs for which you just cannot find people.

***In all events* CONSULT**

Hymatic Automation

166

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- MIDDLE BEARING TO SPINDLE
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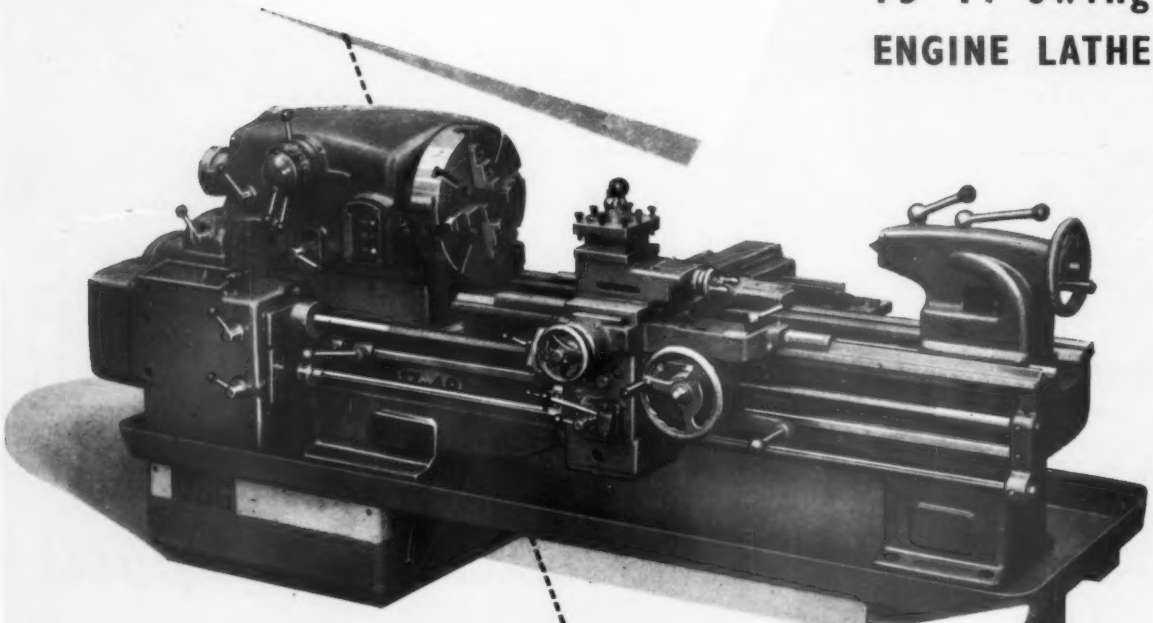

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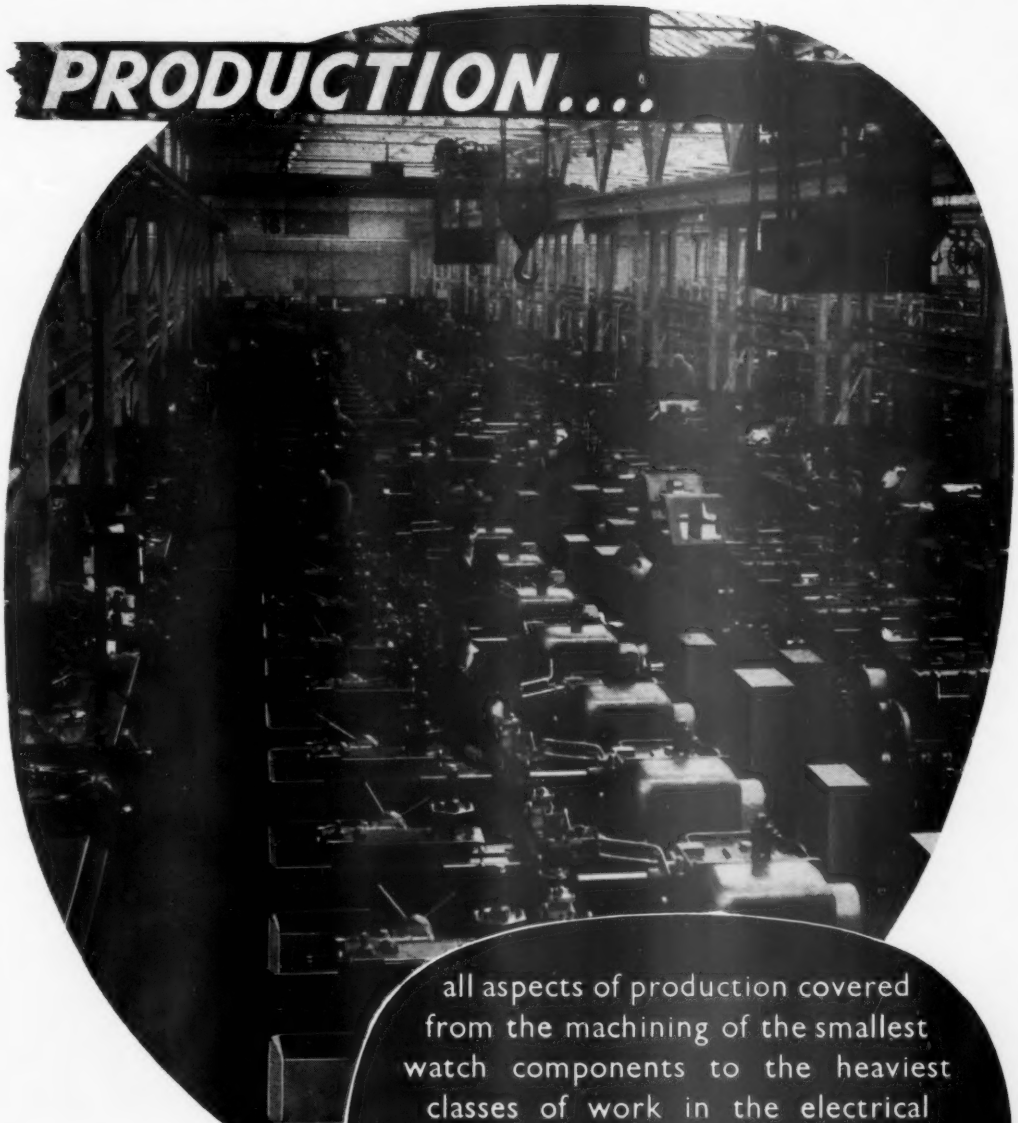

all aspects of production covered from the machining of the smallest watch components to the heaviest classes of work in the electrical and shipbuilding industries

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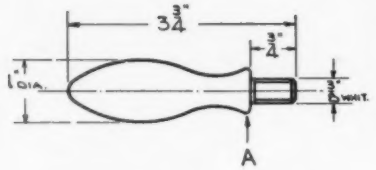


Fitted with 1¼" Hand Operated Automatic Chuck and Swing Forward Covered Bar Feed

STEM HANDLE

1" dia. Free Cutting Mild Steel Bar, En.1.

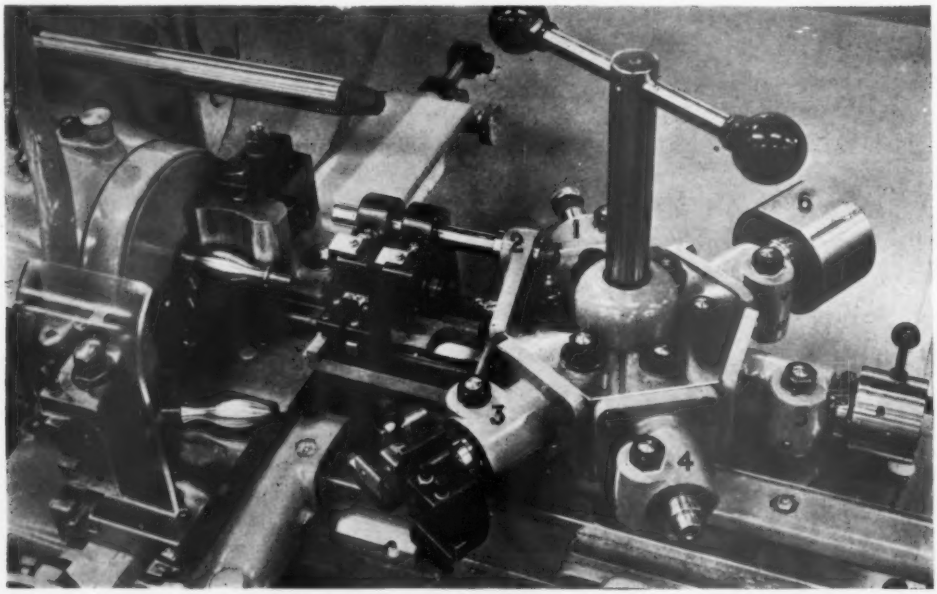
High Speed Steel Cutting Tools

Ward

No. 2A CAPSTAN LATHE

Floor to Floor Time: 70 seconds

DESCRIPTION OF OPERATION	Tool Position		Spindle Speed R.P.M.	Surface Speed Ft. per Min.	" Feed Cuts per inch
	Hex.Turret	Cross-slide			
Feed to Stop and close chuck	1	—	—	—	—
Multiple Roller Turn Two dias. A and ⅝" dia.	2	—	2041	535	120
Roller End and Chamfer	3	—	2041	200	Hand
Support and Form	4	Rear	605/95	160/25	Hand
Screw ⅜" Whit.	5	—	605	60	16 T.P.I.
Support and Radius Part-off	6	Front	605	60	Hand



Capacity: 1⅜ in. dia. hole through spindle. 11¼ in. dia. swing over bed.

Spindle: Mounted in ball and roller bearings.

Powerful friction clutches running in oil transmit power through ground gears.

OUR COMPLETE RANGE INCLUDES CAPSTAN AND TURRET LATHES WITH CAPACITIES UP TO 35 in. SWING OVER BED AND 8½ in. DIA. HOLE THROUGH SPINDLE.

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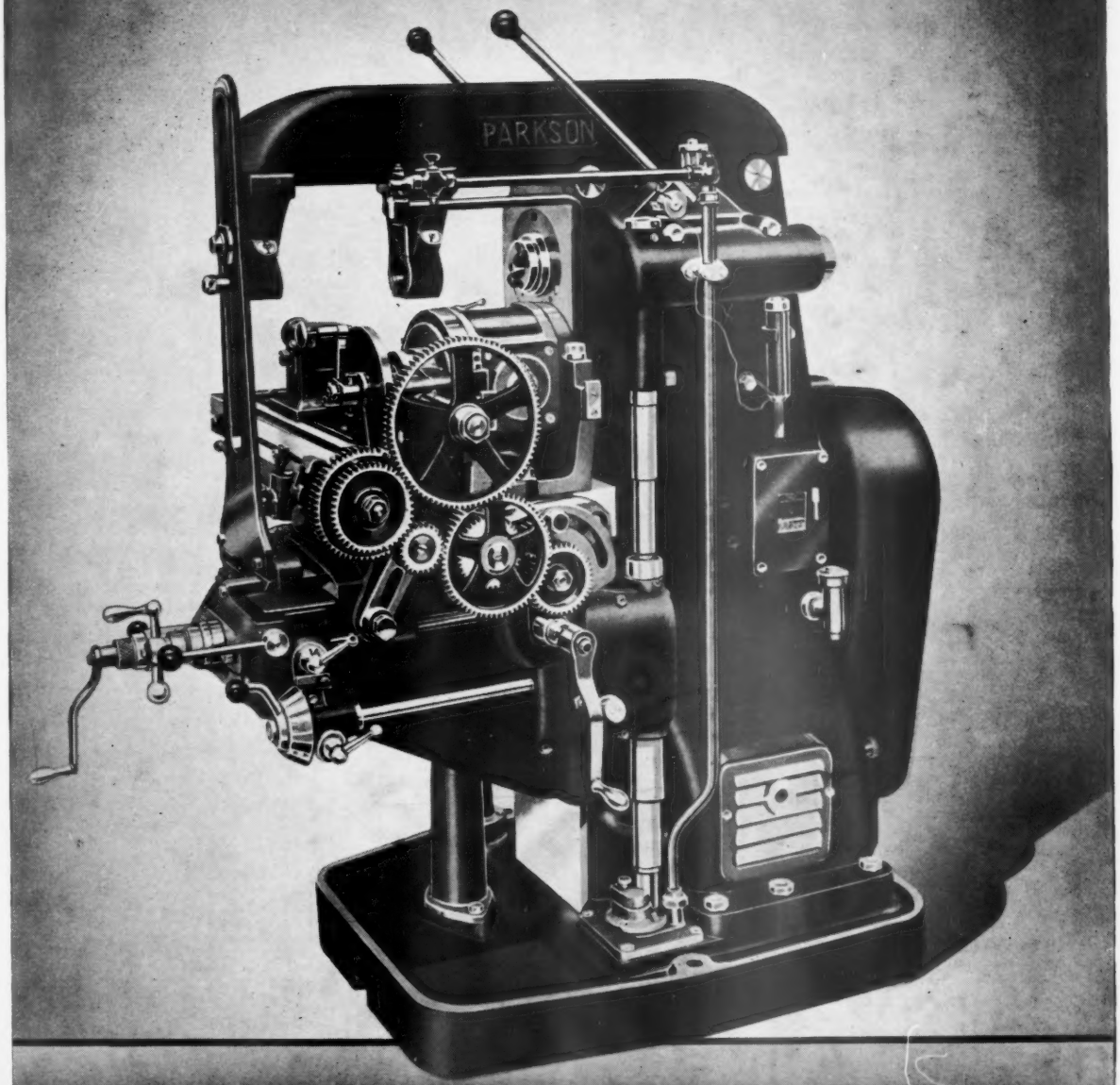

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P.320B

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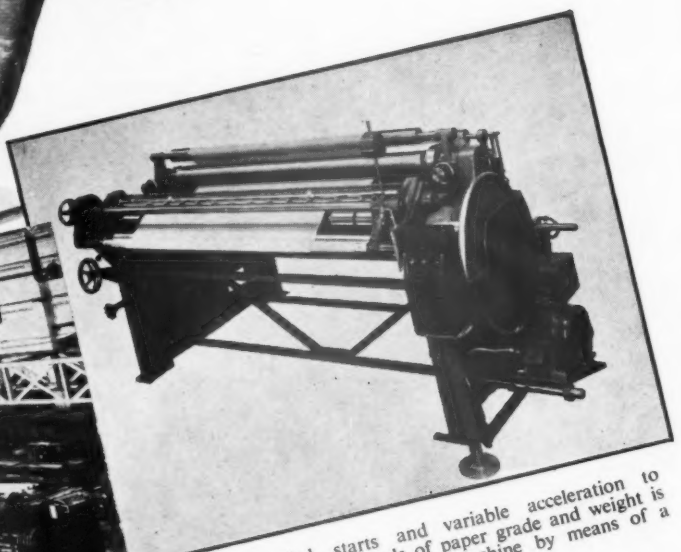
Let us tell you more about them.



Slow controlled starts and variable acceleration to meet the exacting demands of paper grade and weight is achieved on this T.H. Dixon machine by means of a Warner No. 825 Clutch.

This Joshua Bigwood 800 Ton stretch-flattening machine has a Warner 1525 Clutch, giving remote precise control with ease and simplicity.

WARNER WESTOOL LIMITED

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are manufactured in Great Britain under licence by

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TIB.29

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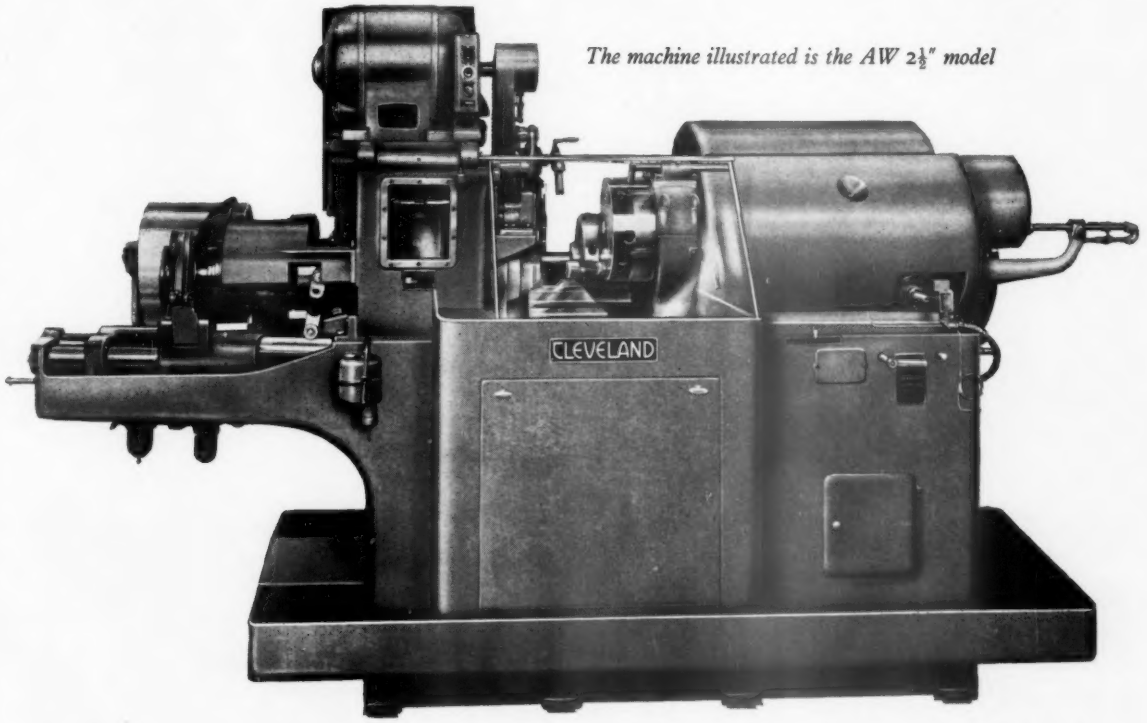

The machine illustrated is the AW 2½″ model

BRIEF SPECIFICATION OF AW 2½″

Spindle Capacity	2½″
Number of Spindle Speeds	40
Spindle Speed range r.p.m.	69 *to* 1920
Automatic Speed Changes—forward or reverse	4
Maximum Travel	1¾″
Cross Slide Travel	3 3/16″

To meet your special engineering problems CLEVELAND Single Spindle Automatics are now available in a new extensive range comprising:—

Model "AB" 1⅜″ with electric drive.
Model "AB" 1⅝″ " " "
Model "AB" 3″ " " "
Model "AB" 3¾″ " " "
Model "AB" 4¼″ " " "
Model "AB" 5¾″ " " "
Model "B" 2½″—18″ machine

Model "A" 1 1/16″
Model "AW" 2½″
Model "AW" 4¼″
Model "AW" 5¾″
Model "A" 8″
Model "B" 1 1/16″
Model "B" 1½″

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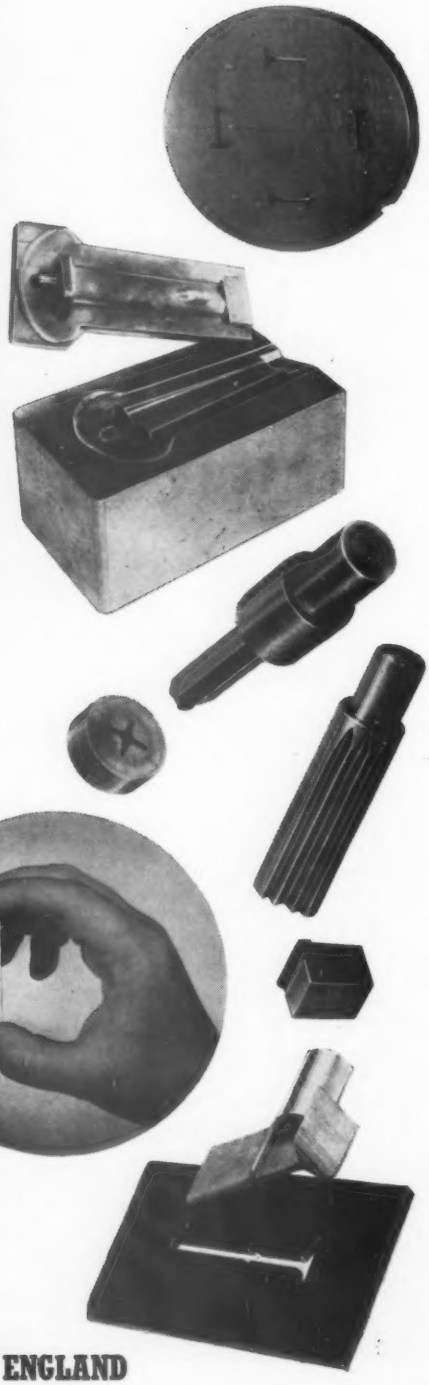

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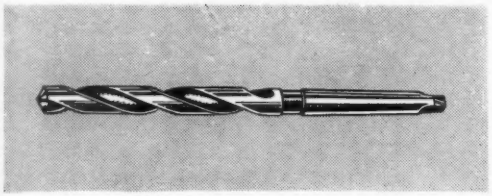

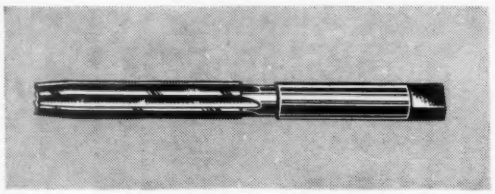

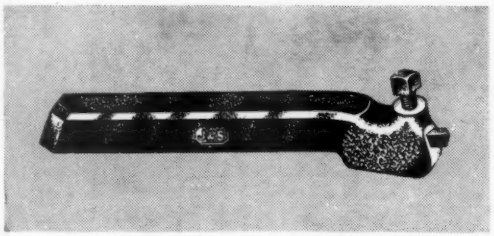

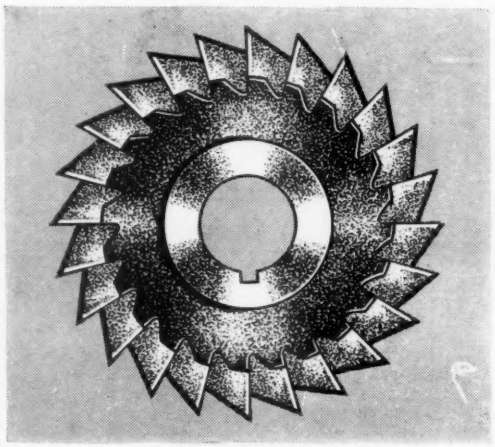

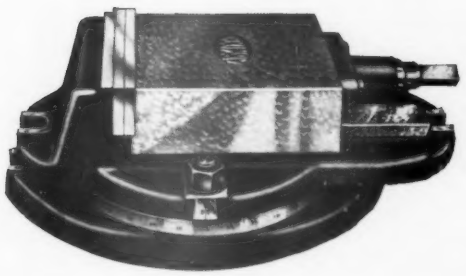

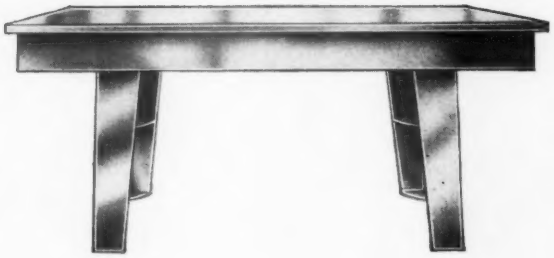

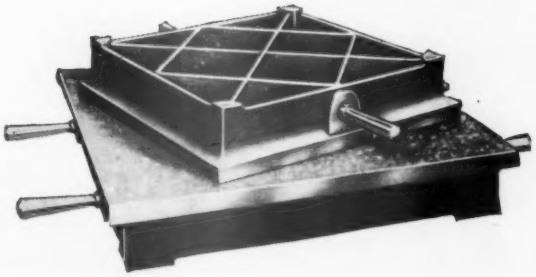

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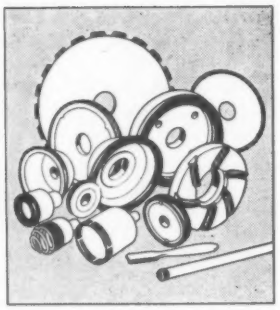

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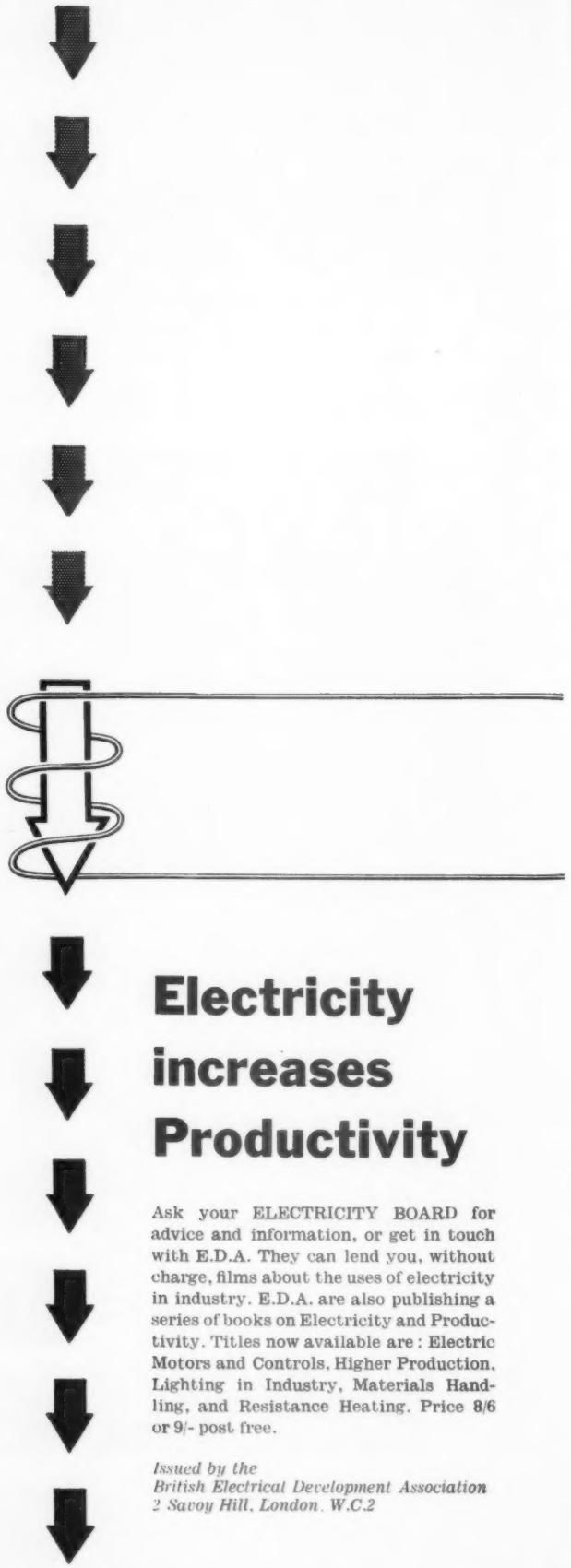

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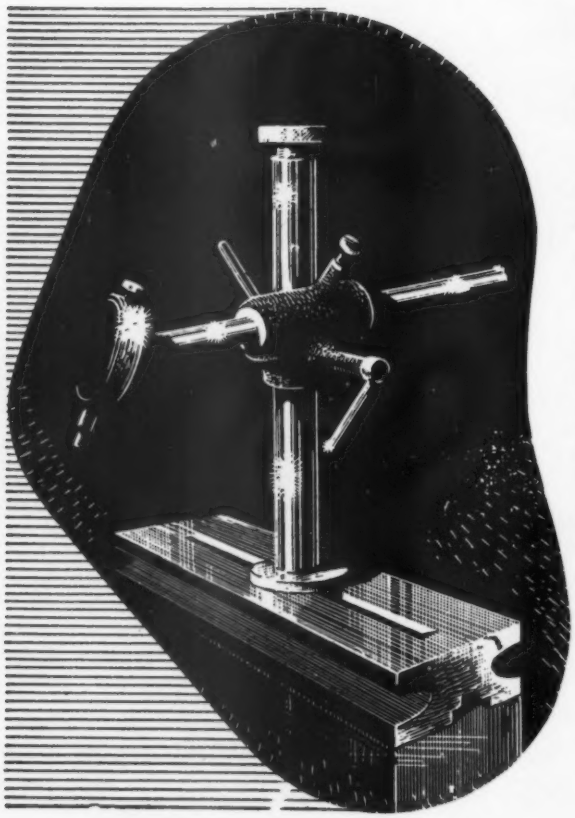

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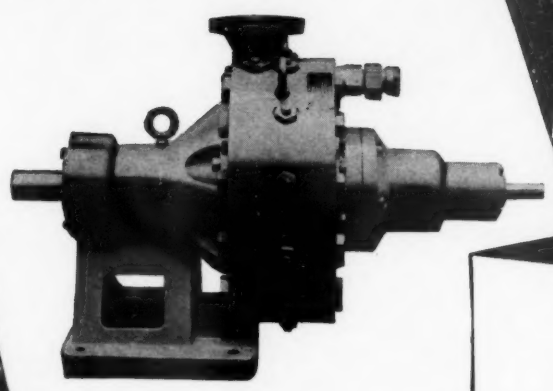

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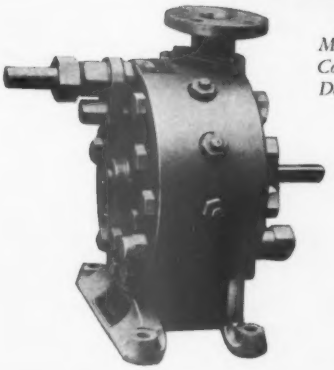

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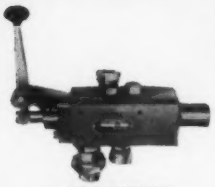

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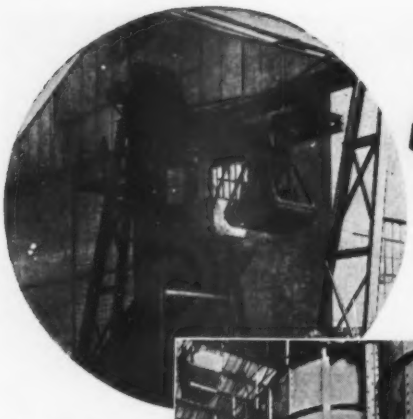

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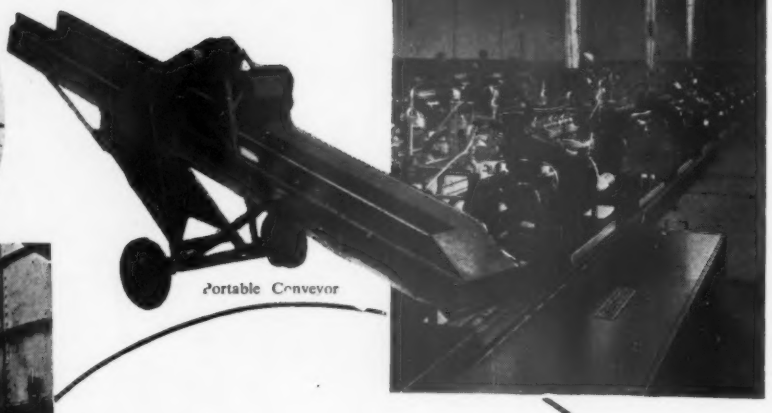

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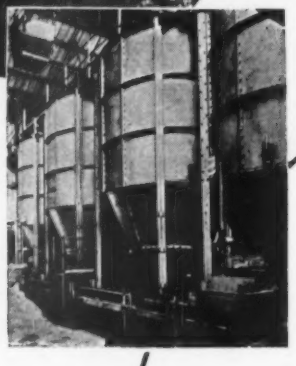

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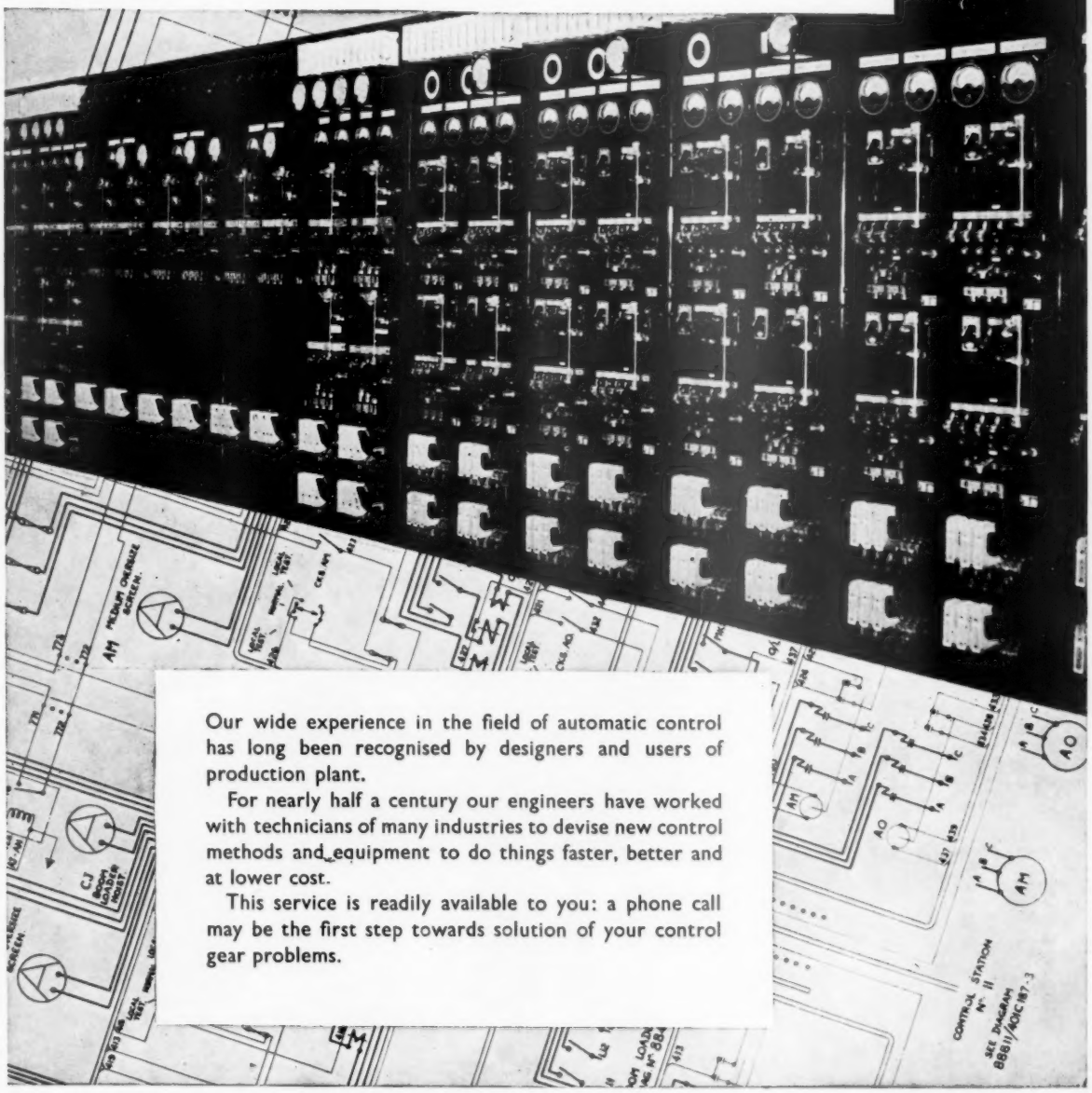

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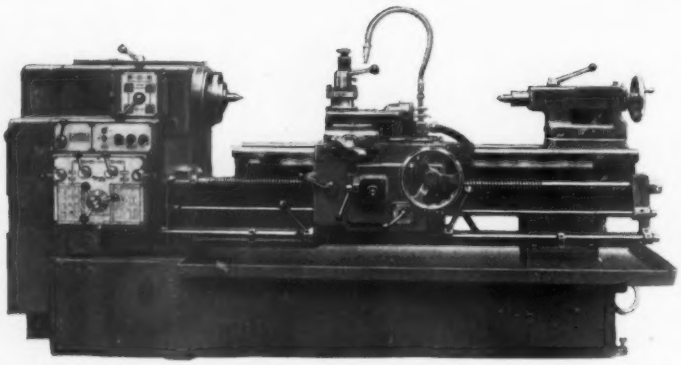

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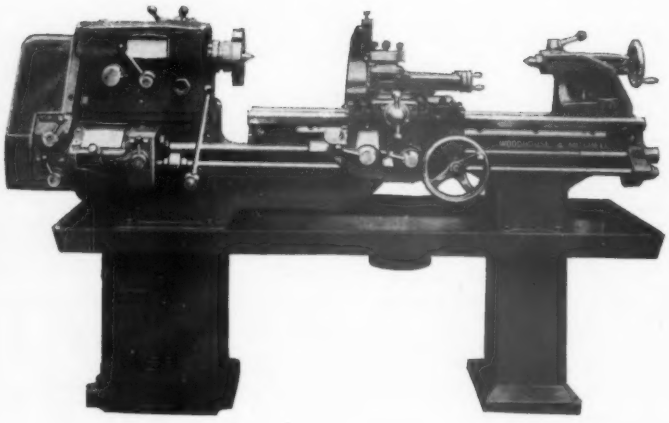

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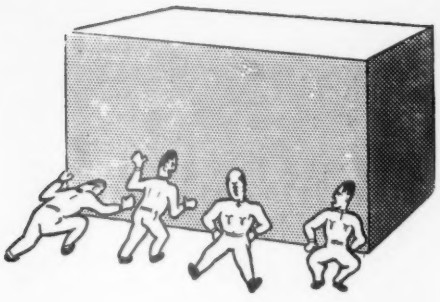

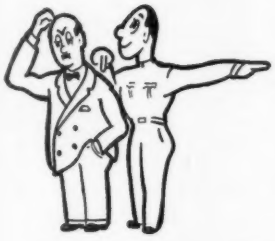

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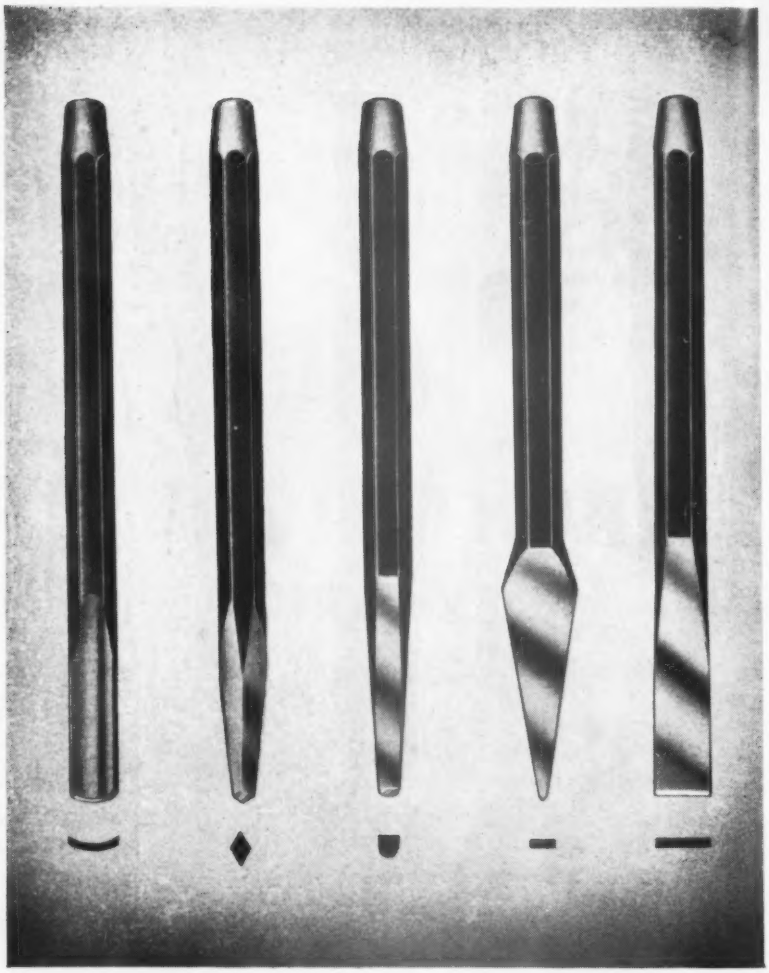

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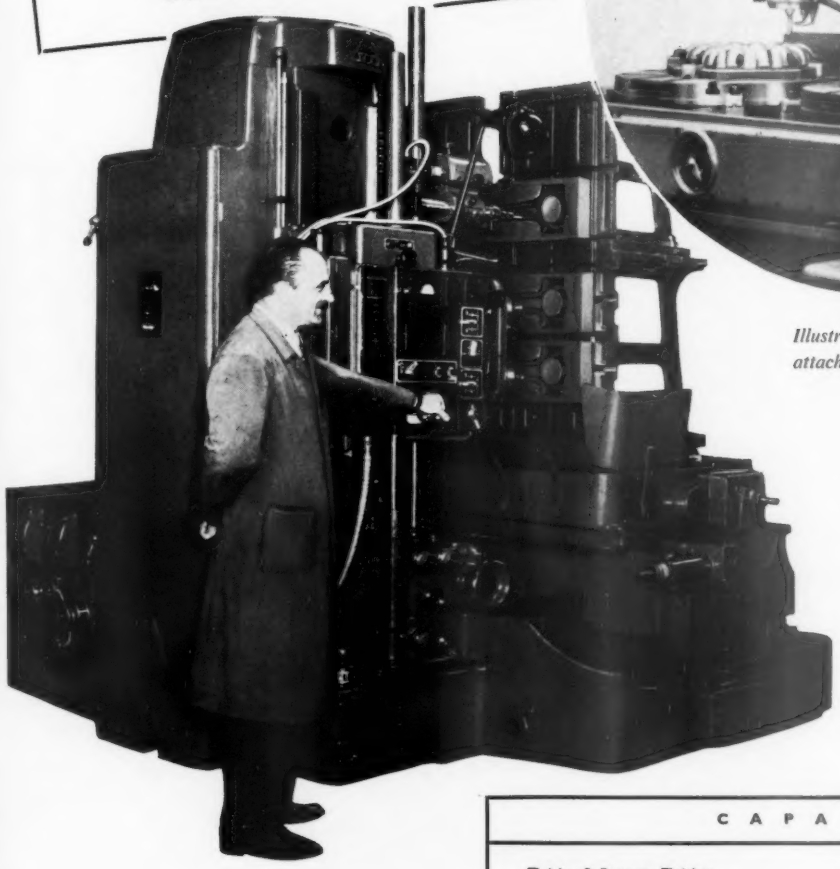

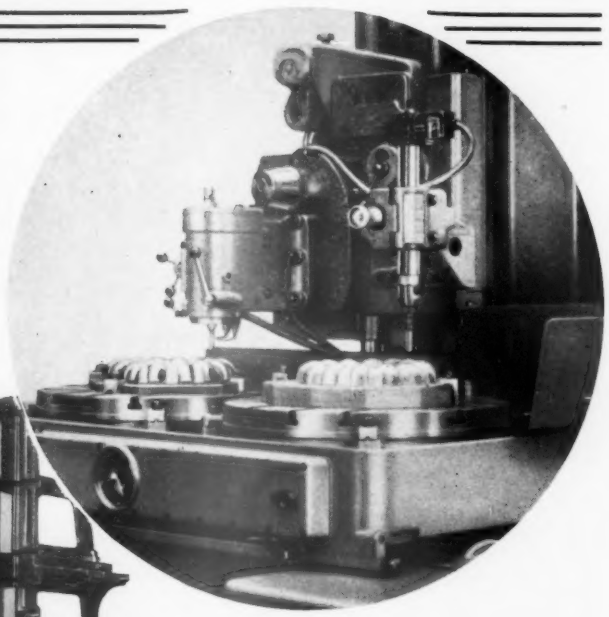

Illustration shows machine fitted with vertical attachment—copying using the two rotary tables

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Transverse movement of slide	15⅞in.
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Spindle Speeds (8)	70 to 800 or 335 to 3,600 r.p.m.
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Longitudinal Table Feed (per min.)	25/32in. to 8¾in.
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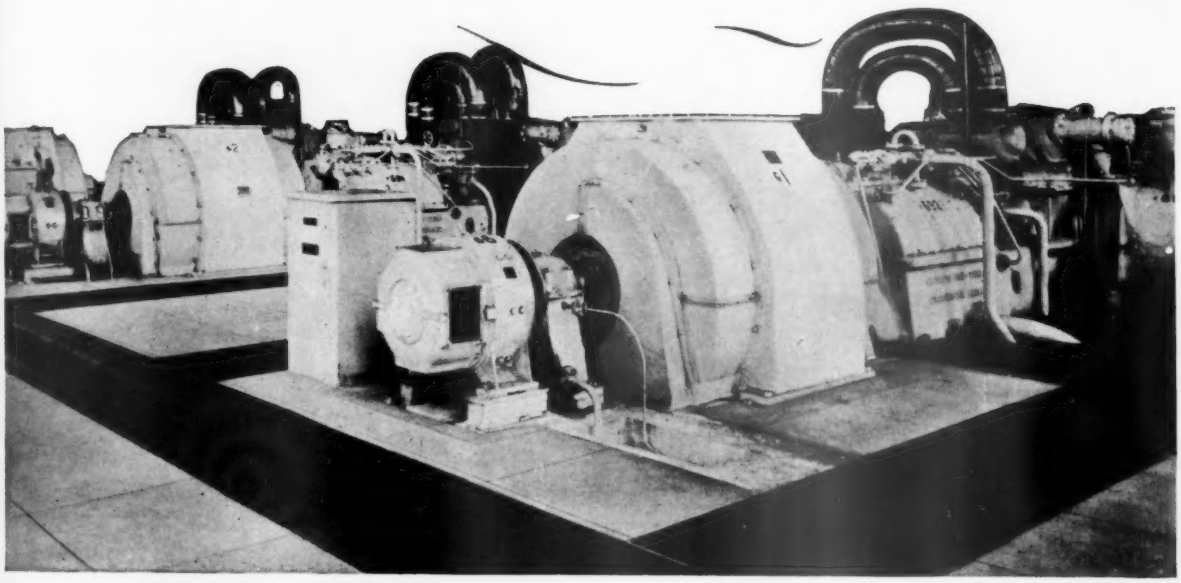

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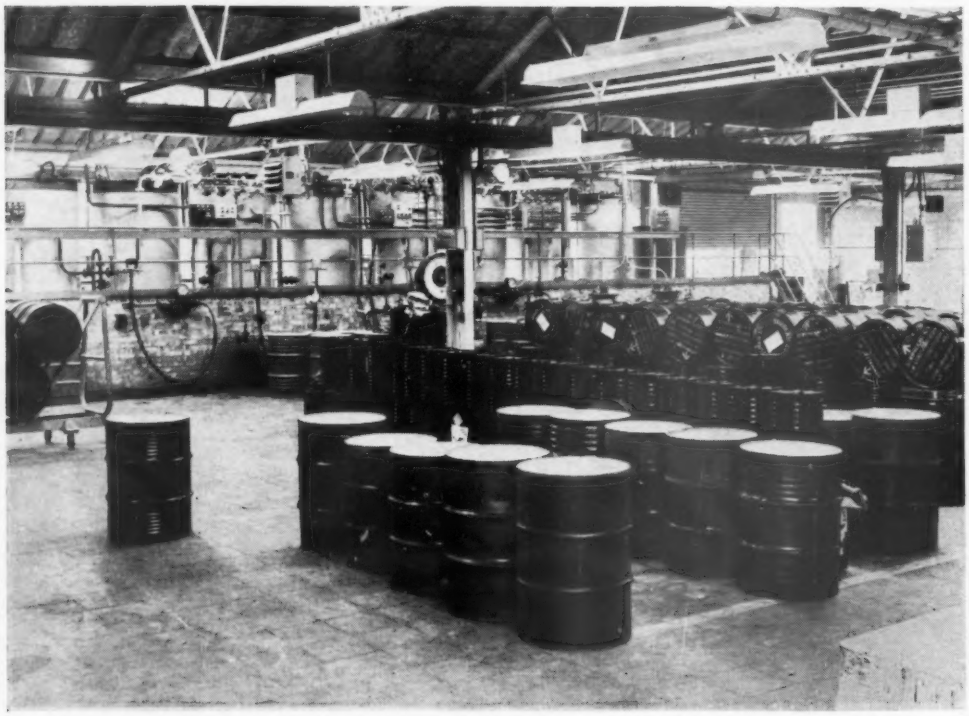

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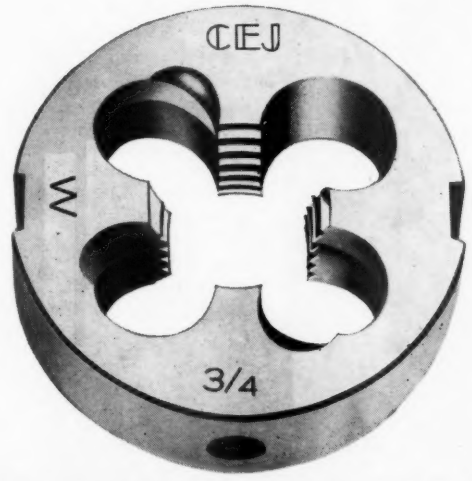

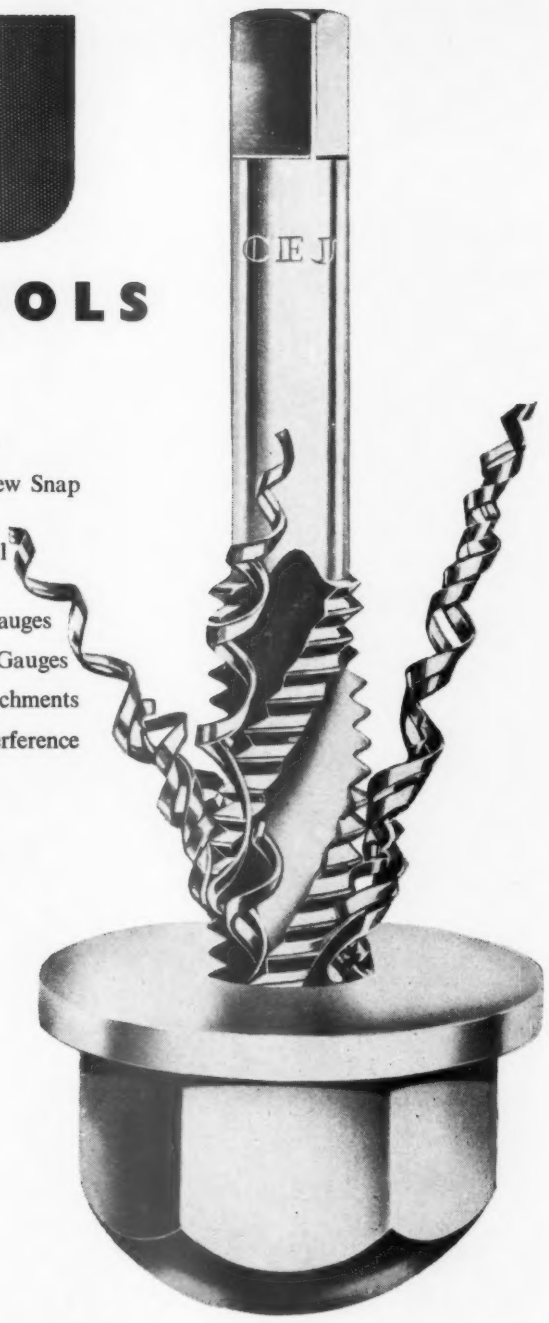

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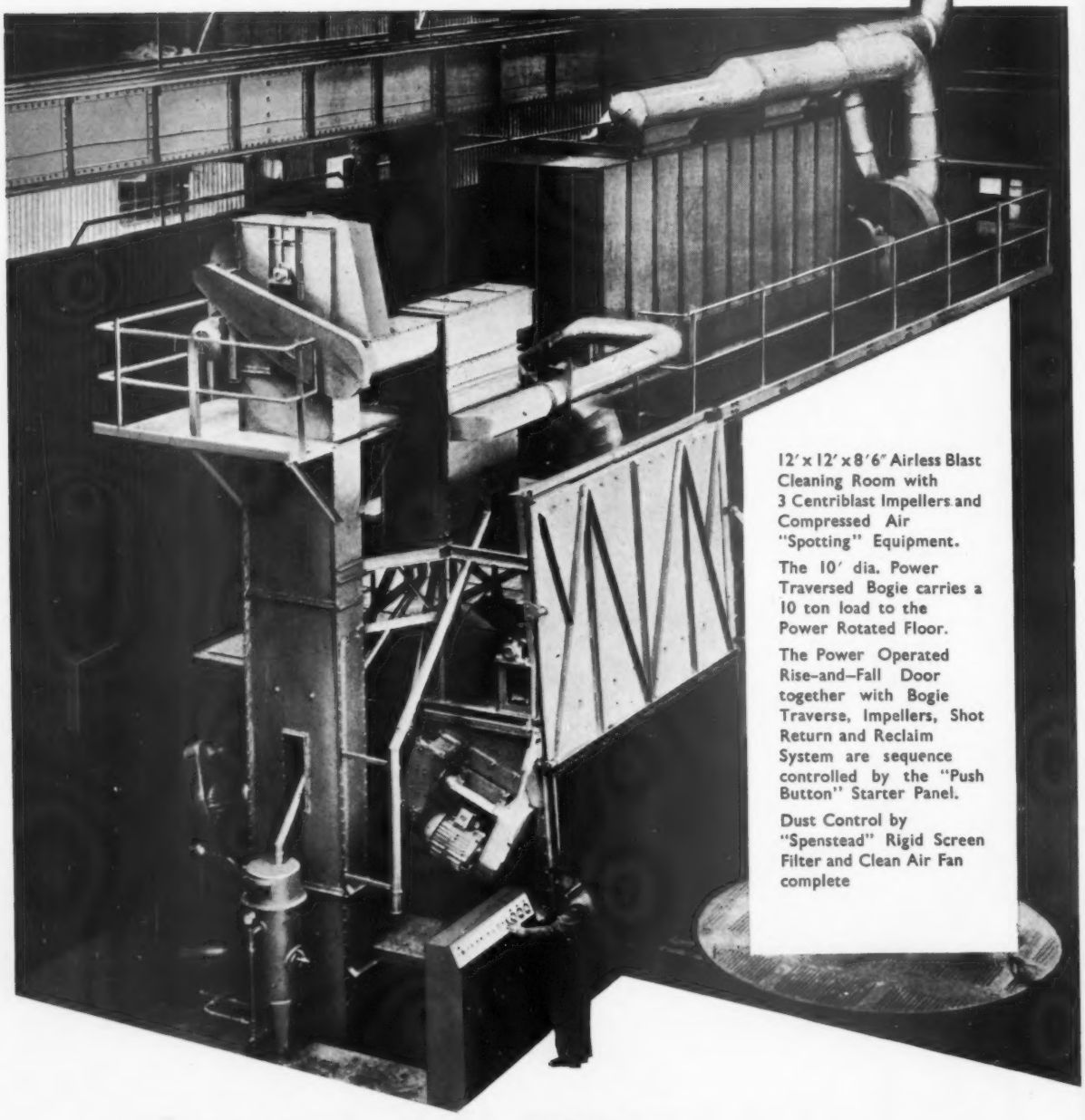

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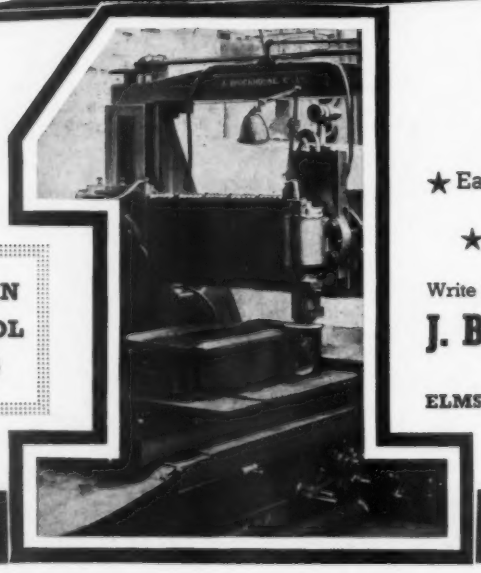

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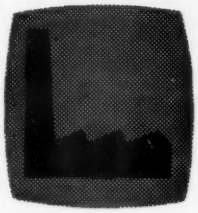

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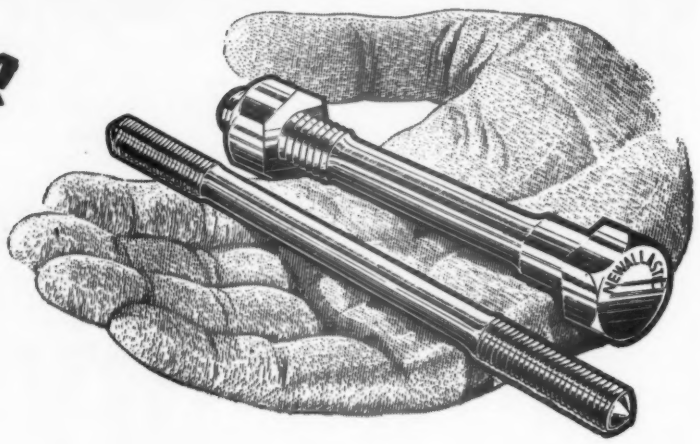

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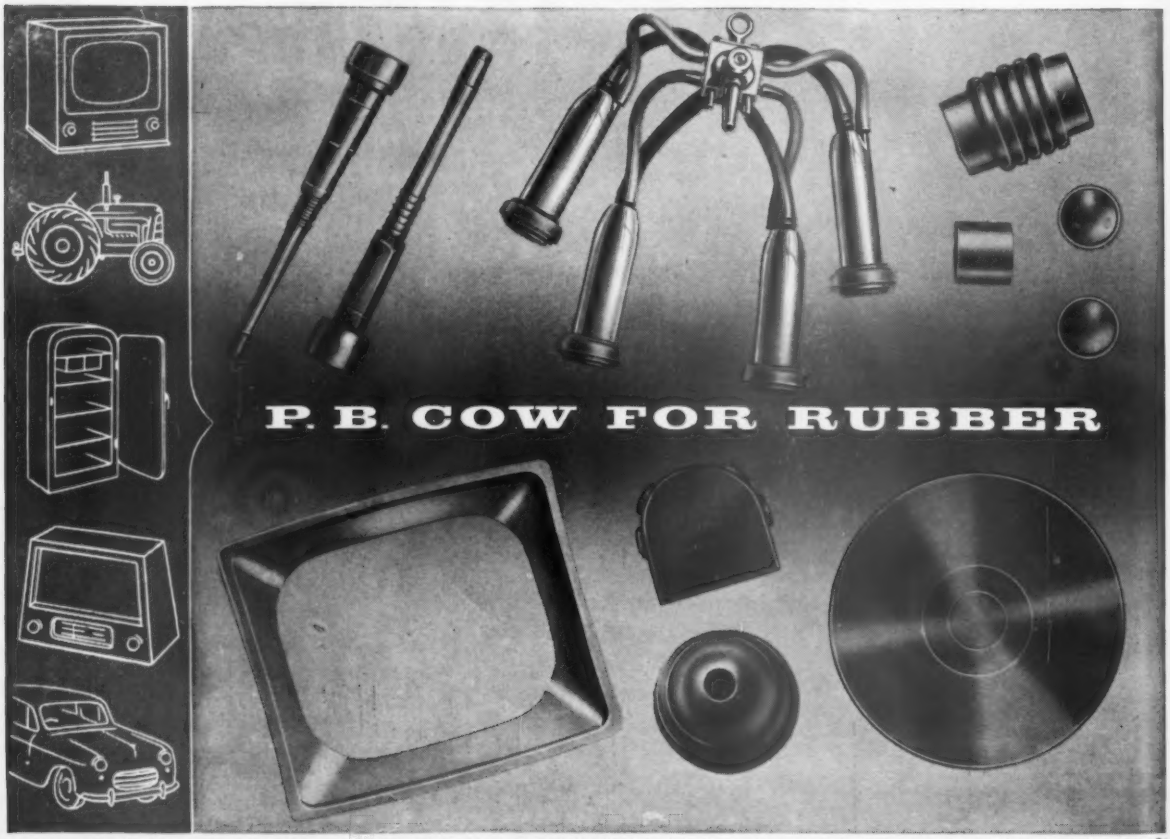

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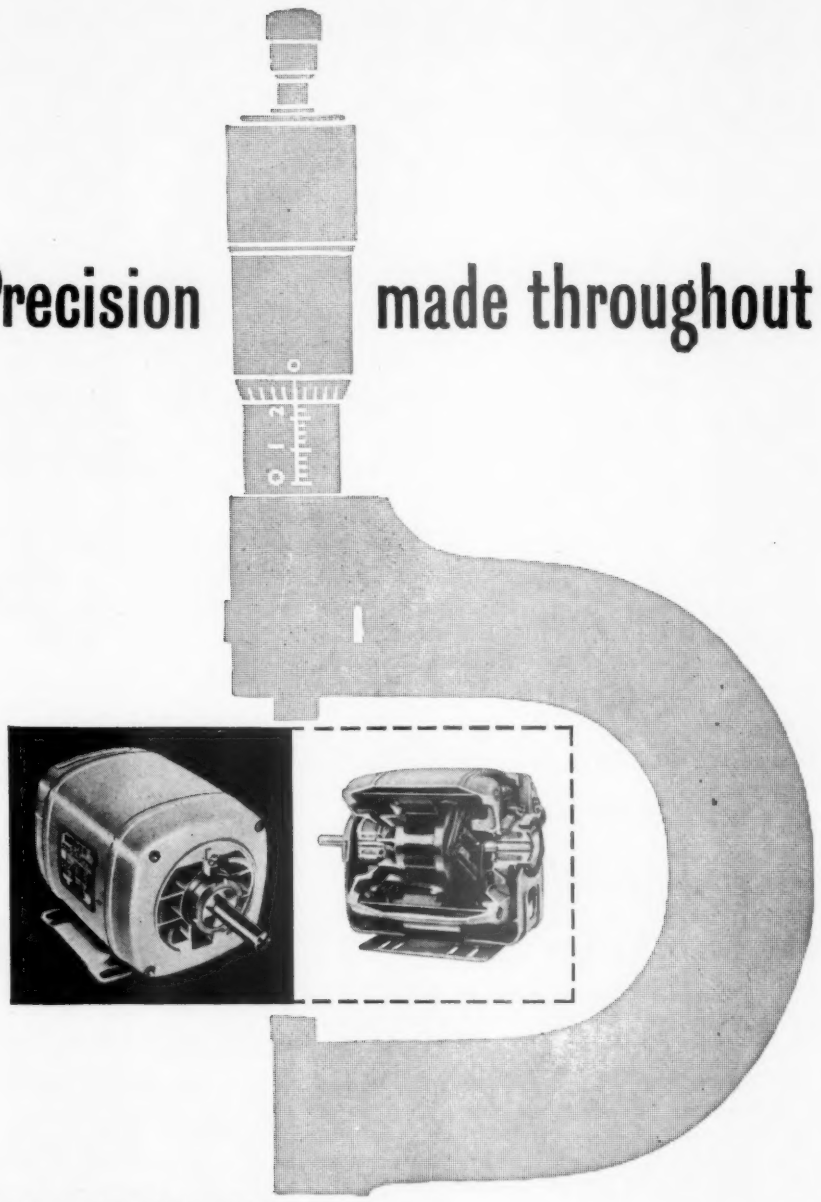

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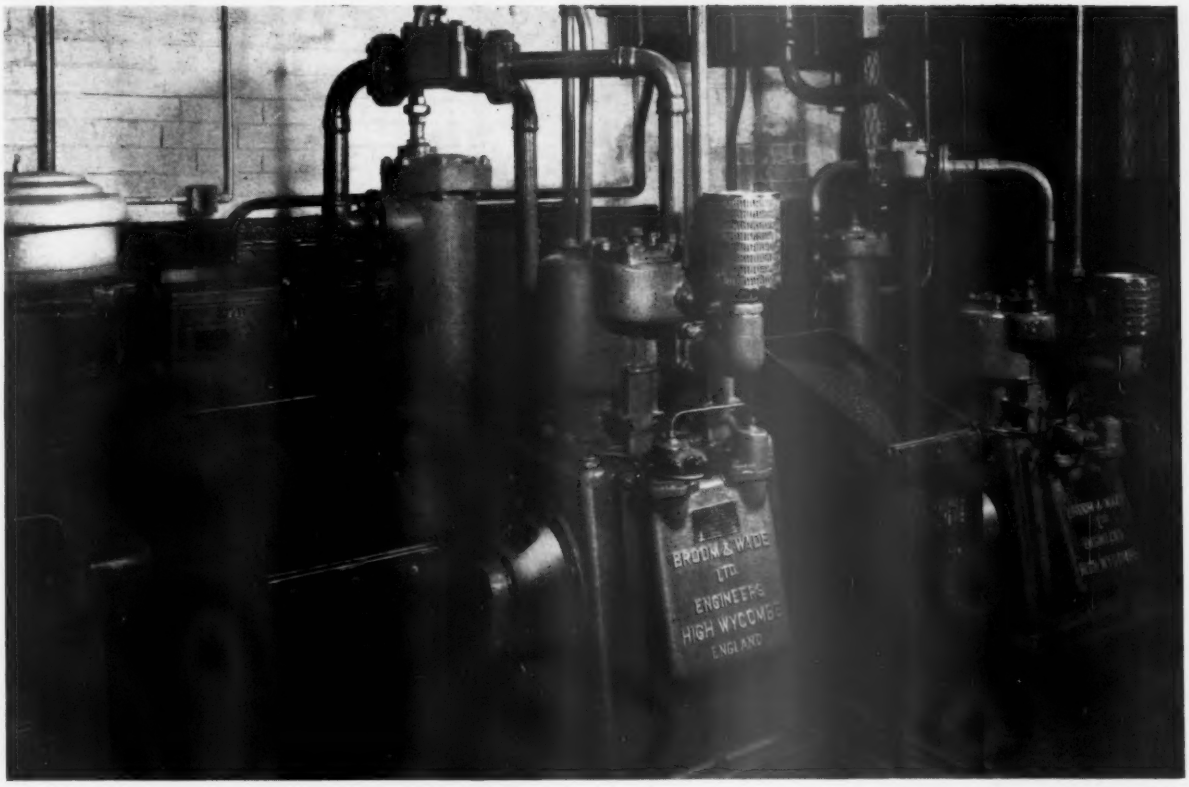

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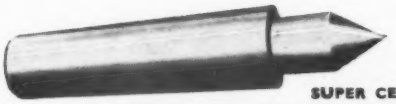

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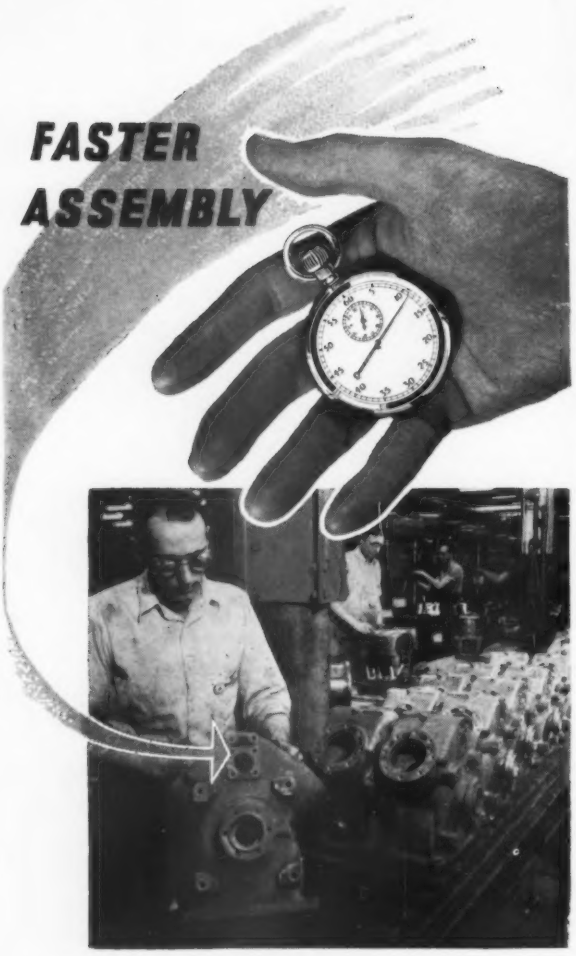

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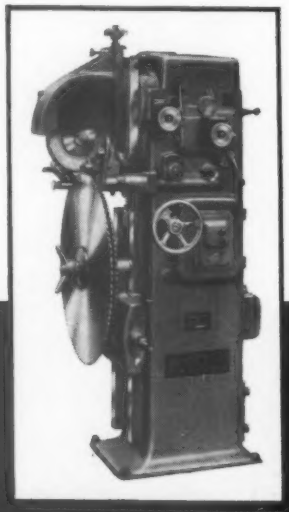

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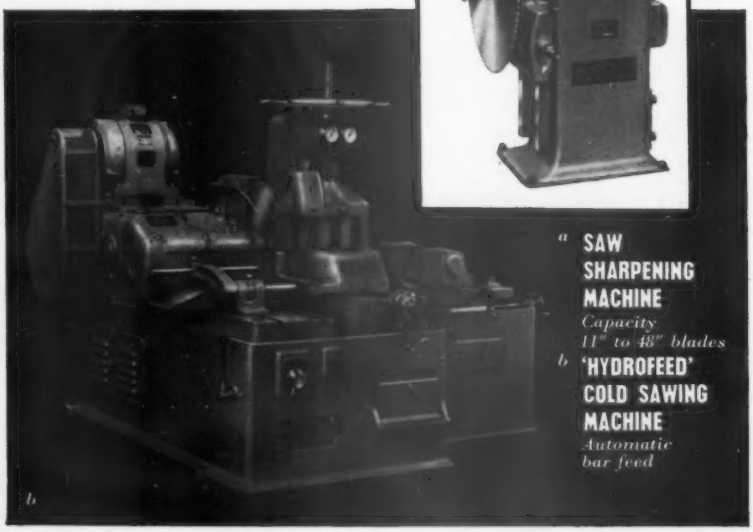

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Capacity 11" to 48" blades

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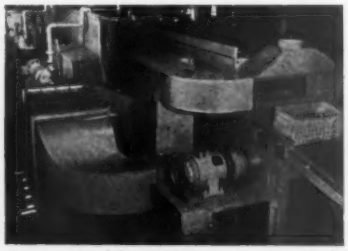
HERE ARE THREE EXAMPLES

INDUSTRIAL CLEANING MACHINES
can be designed to meet your particular cleaning problems

This illustration shows a machine cleaning crank cases in the production line. It is equally capable of cleaning small parts in baskets.



A power driven conveyor system is employed with this cleaning machine for ball bearings.

Trays carrying the work are pushed through on a roller conveyor by hand in this cleaning installation.

Whilst offering a very wide variety of standard cleaning equipment, it is BRATBY policy, wherever possible to design the machine to meet the particular cleaning problem. Careful study of each individual problem ensures maximum efficiency and economy of the plant in operation. The illustrations show but a few of the specific types of Cleaning Machines designed by BRATBY for individual needs.

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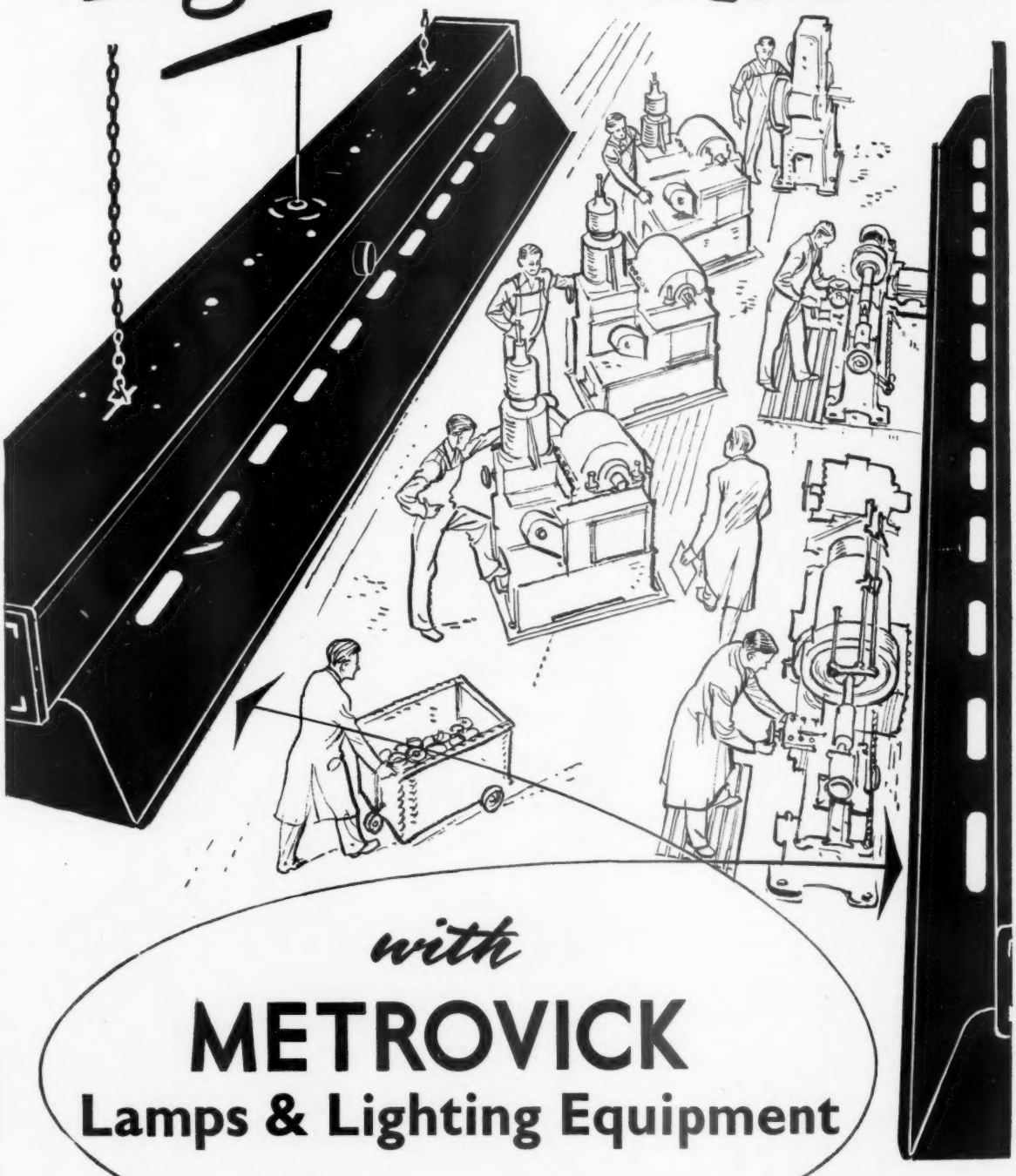

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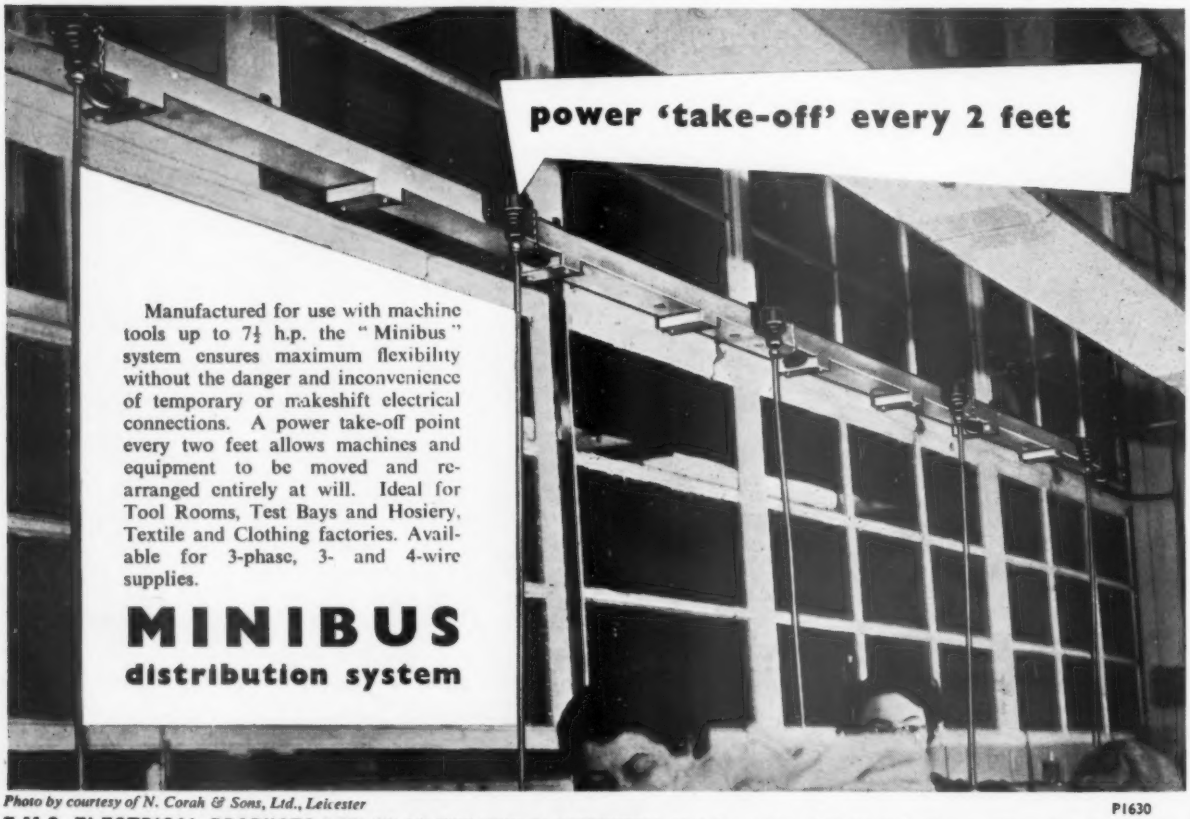

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distribution system

Photo by courtesy of N. Corah & Sons, Ltd., Leicester

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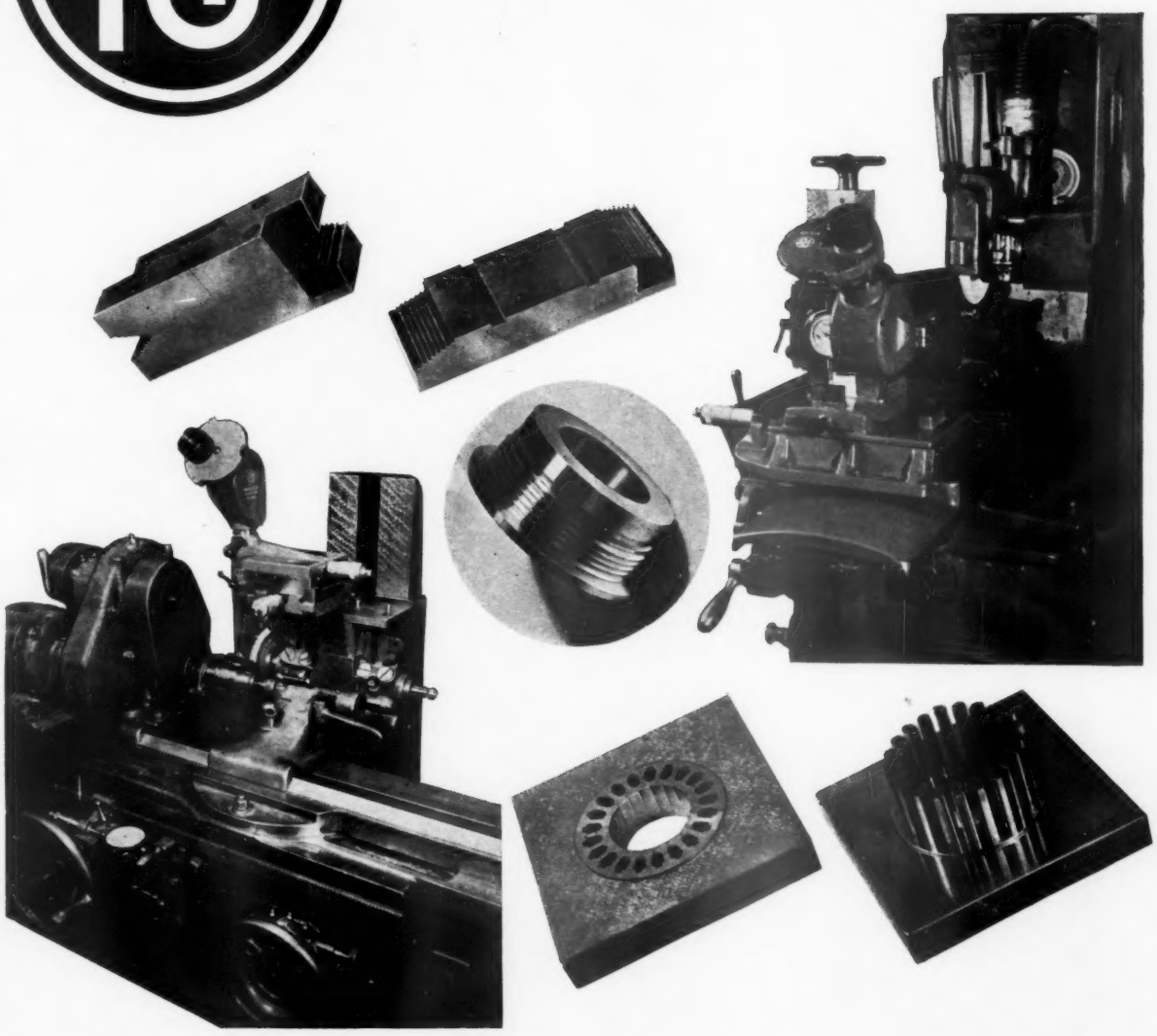

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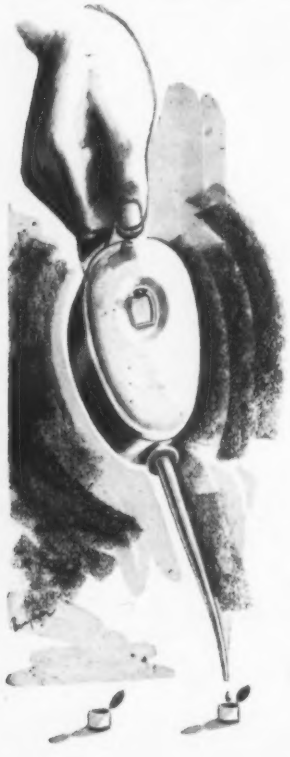

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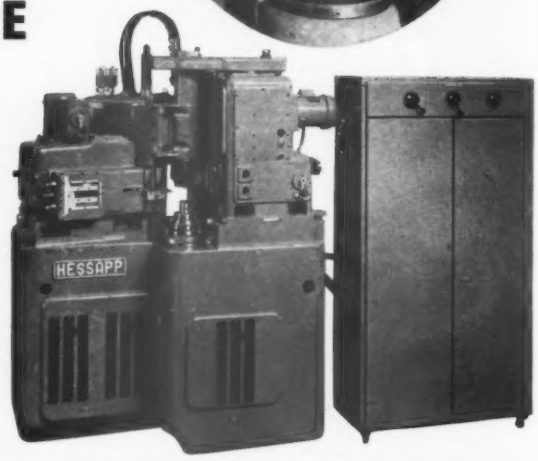

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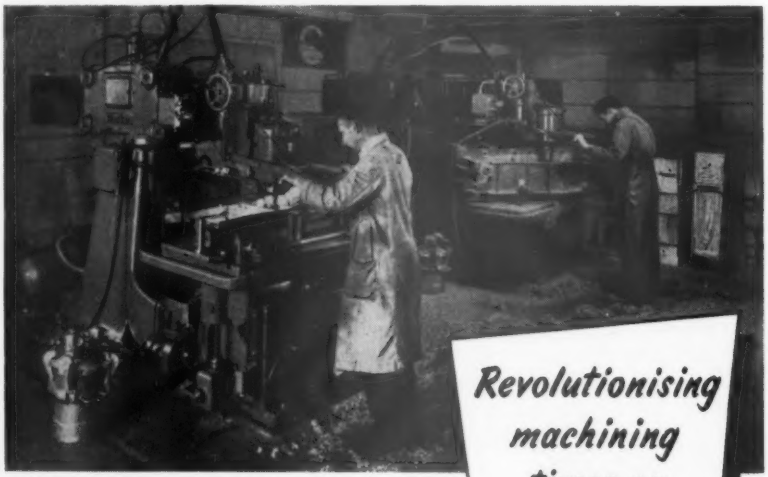

Machining aircraft components in light alloy
Photograph by courtesy of Messrs. Morfax Ltd., Mitcham.

This Wadkin Heavy Duty Radial Arm Router type L.Y.R. will machine practically all the aluminium light alloys in cast, forged or rolled forms, also brass, zinc, certain coppers and lead, and it is also suitable for many plastic materials.

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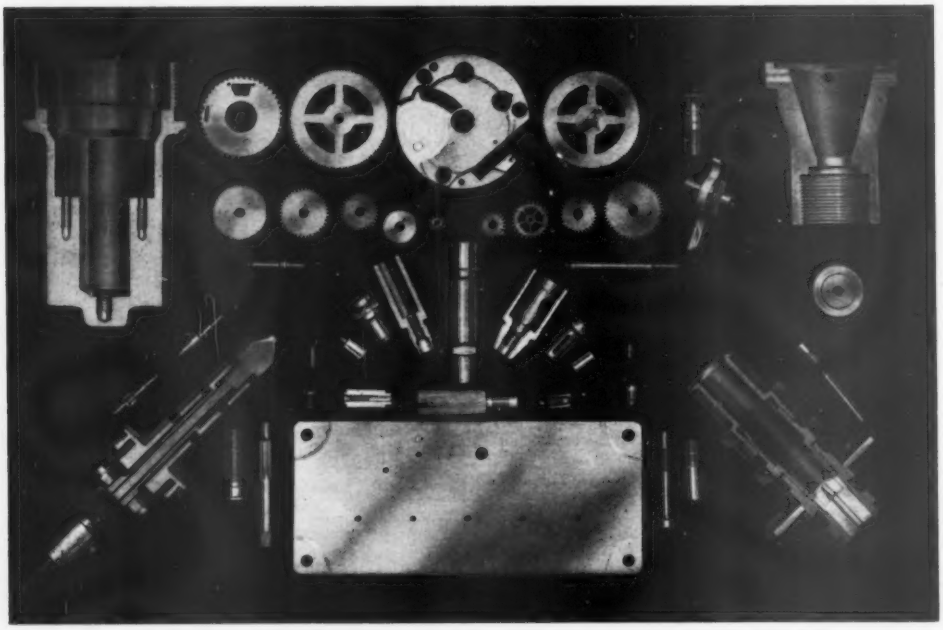

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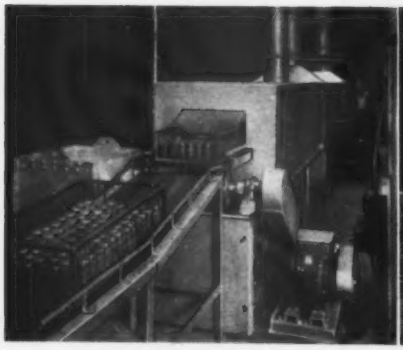
A 'Junior' type machine supplied to a Midlands Motor Car Works.



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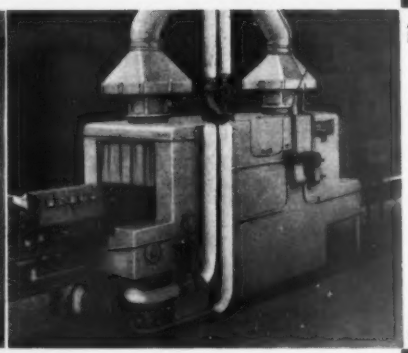

A model 'A' machine, washing parts of motor car engines prior to assembly.

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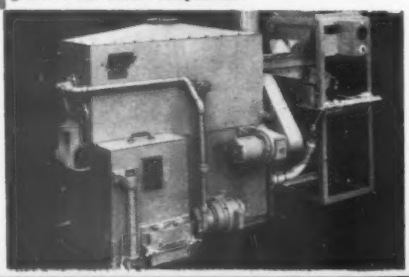
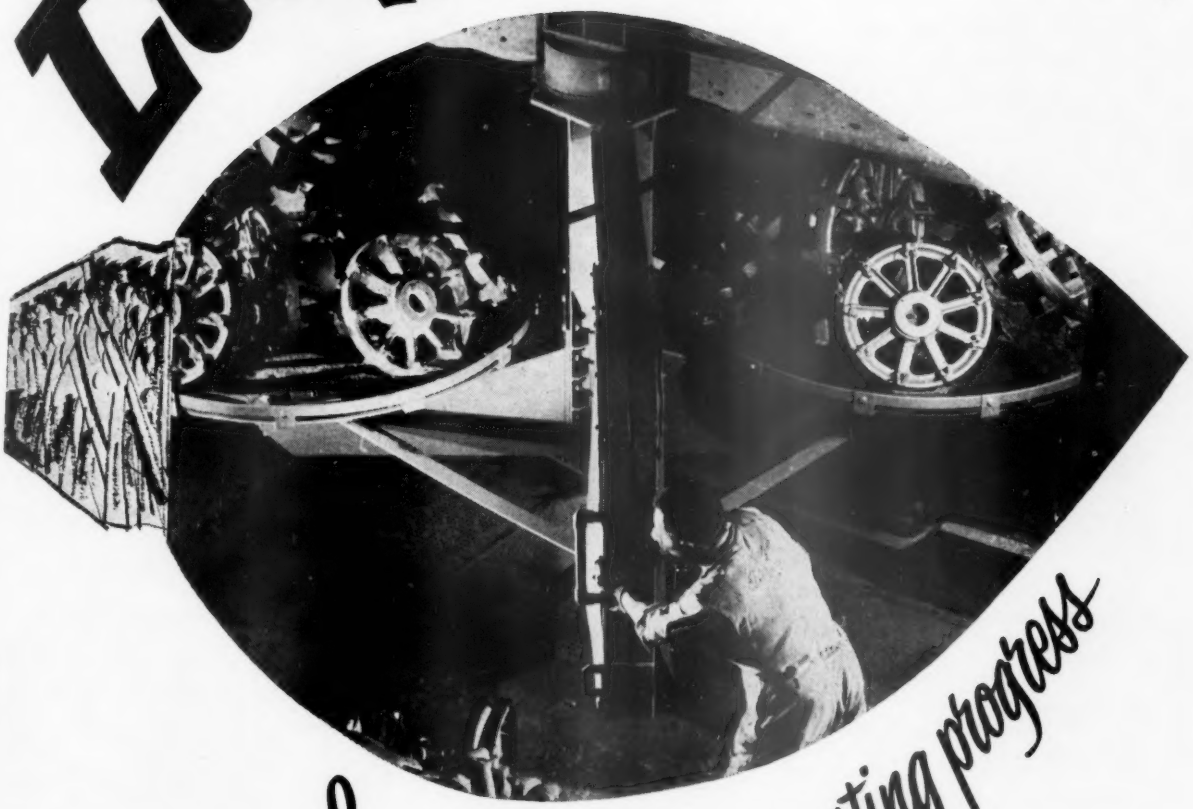


Lloyds



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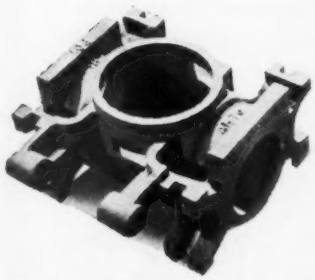

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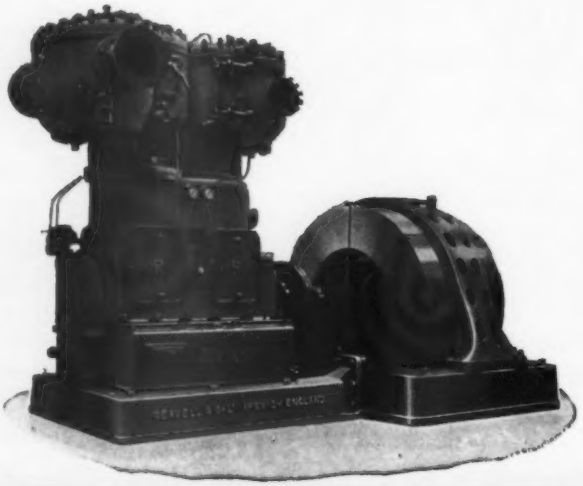

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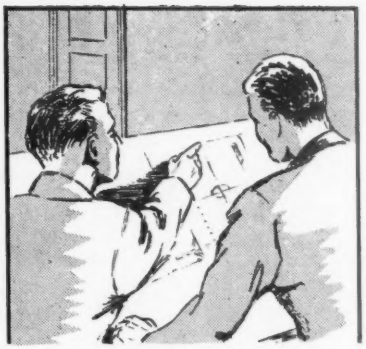
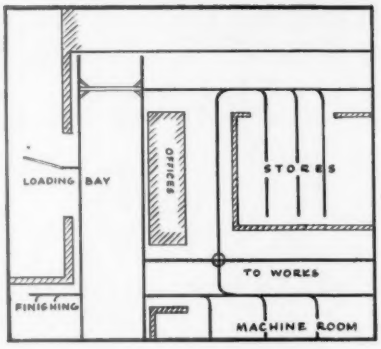
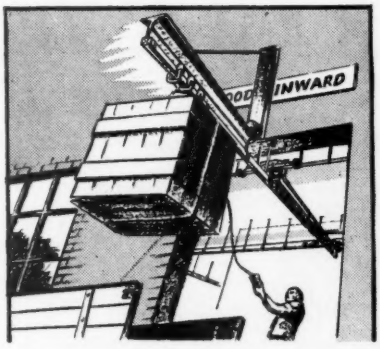


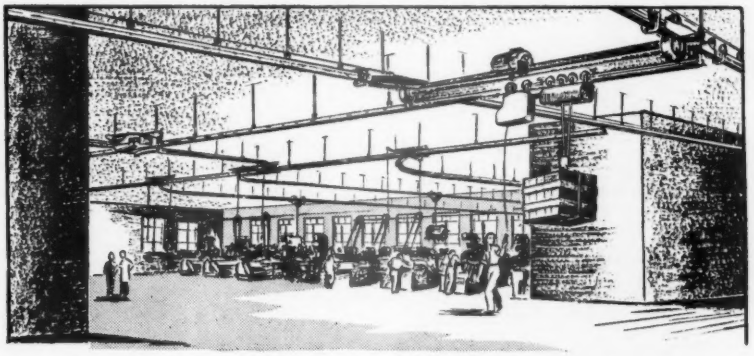
Our engineers will be happy to discuss your problems and submit a scheme in line with your particular requirements.



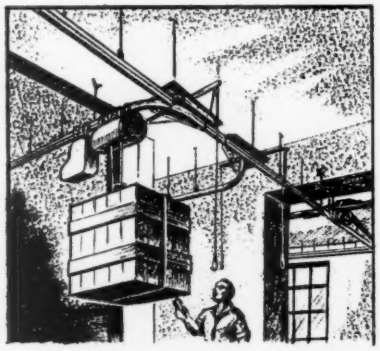
British MonoRail overhead handling equipment is designed for the intermittent movement of loads up to two tons.



Swinging jigs interlocking with connecting tracks provide smooth load transfer without hook changes.



Low dead weight underslung bridge cranes, interlocking with MonoRail track layouts as required, allow accurate load positioning over wide areas and time saving inter shop transfer without the necessity for hook or carrier changes.



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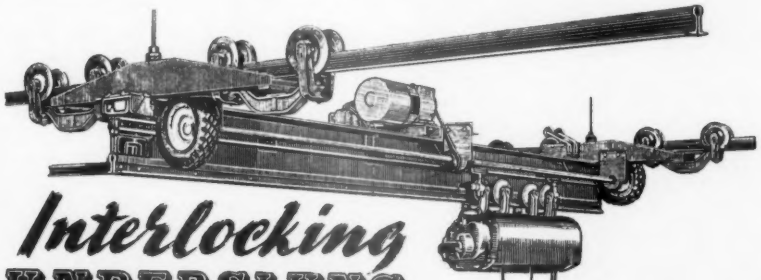

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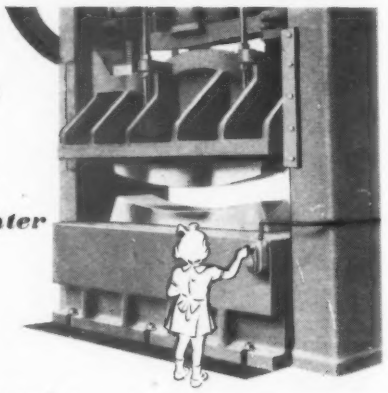

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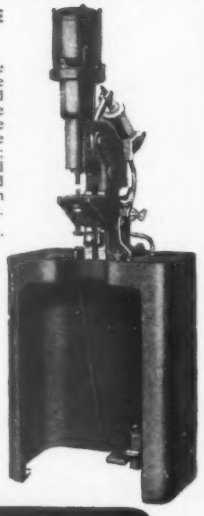

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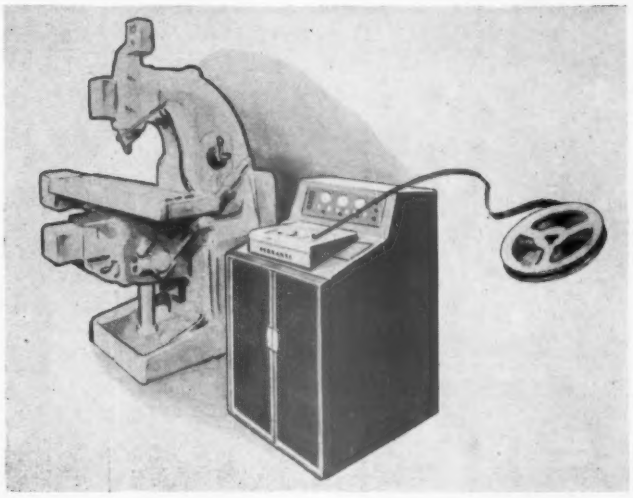

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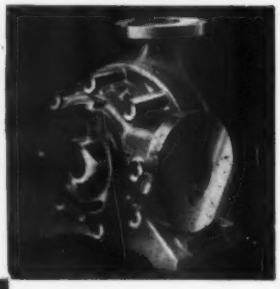

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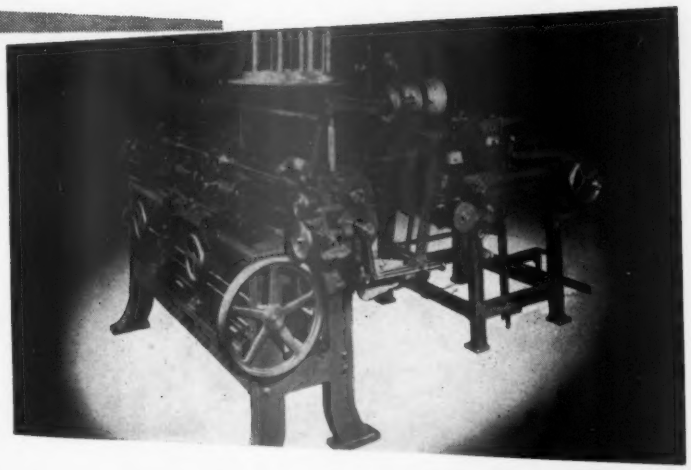

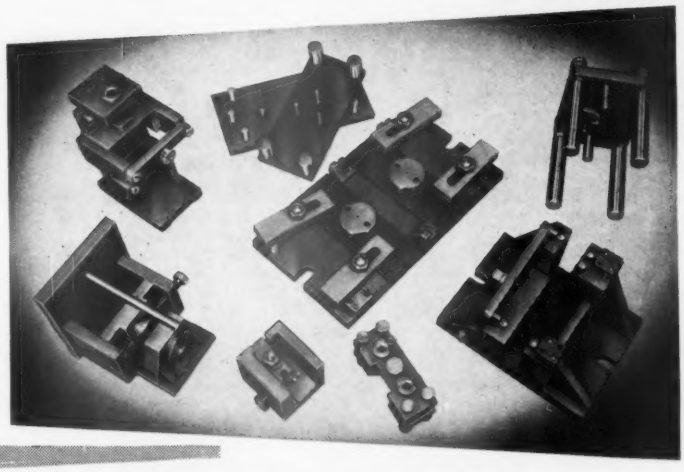

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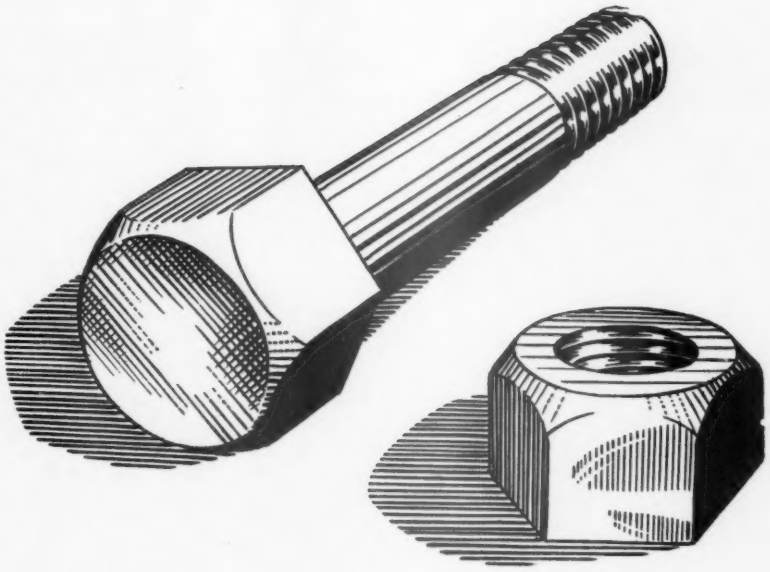

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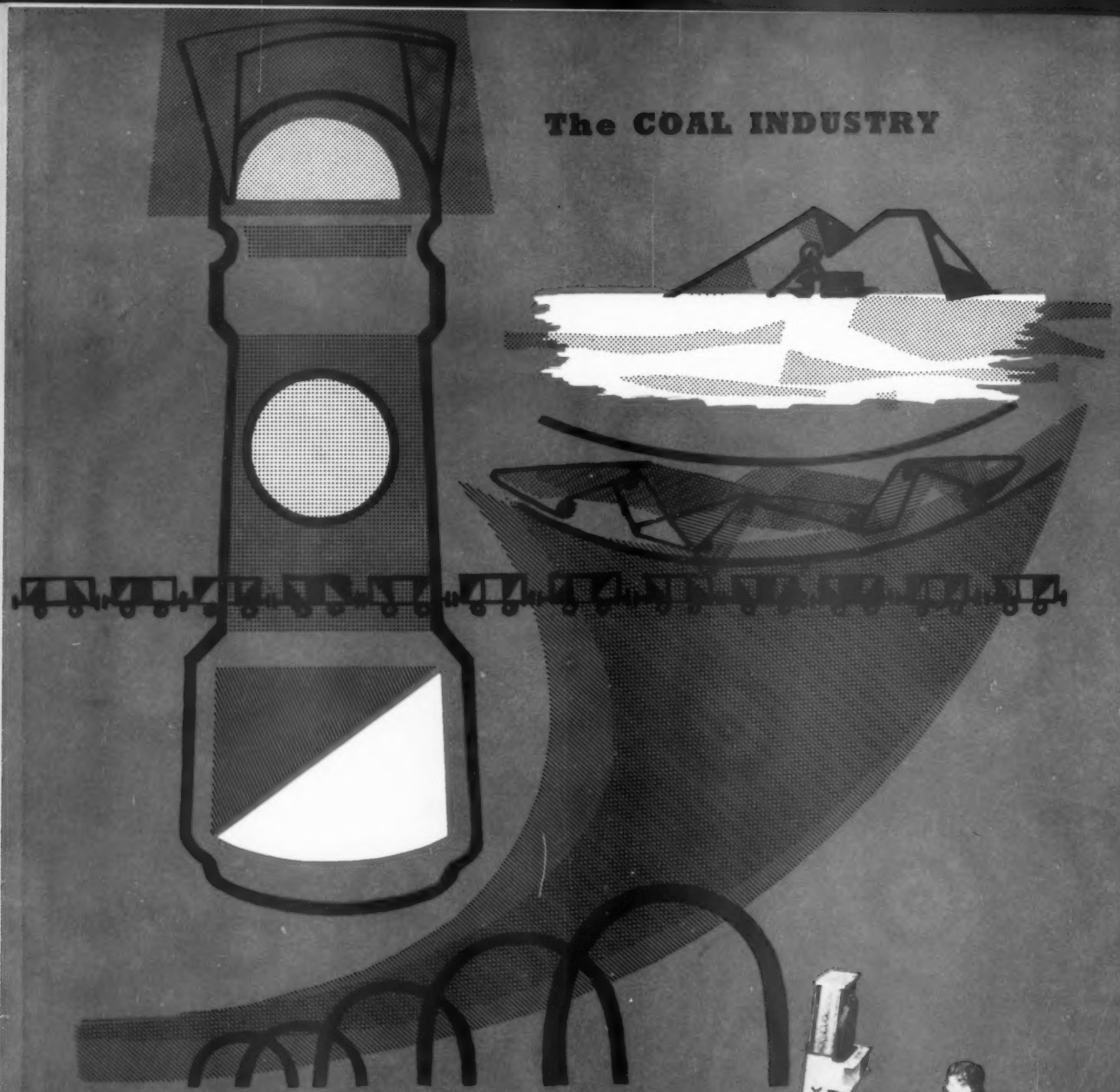

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